USING ADMINISTRATIVE DATA TO INVESTIGATE WAIT TIMES FOR TOTAL JOINT REPLACEMENT SURGERY IN NEWFOUNDLAND AND LABRADOR

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by

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ABSTRACT

Objective: Total wait time for total joint replacement surgery is described, and comorbidities and health service utilization of patients during the wait and length of stay after the procedure are examined.

Methods: Surgery department data for 2002-2005 from eastern Newfoundland and Labrador was linked to physician claims and hospital data to measure total wait time and examine health service utilization and comorbidities. Wait time was grouped into short, moderate, long and very long.

Results: Median total wait time was 47.1 months. Age, hospitalizations and new comorbidities during the wait time were positively associated with length of stay after the replacement. No association was found between total wait time and physician visits or hospitalizations. A weak positive association was found between number of comorbidities and wait time.

Conclusions: Patients wait times are longest before the wait list begins. It may be beneficial to both patients and the health system to reduce the total wait time.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The number of total joint replacement (TJR) surgery being performed each year is increasing (Dunbar, Howard, Bogoch, Parvizi and Kreder, 2009). In Canada, more than 68,700 hip and knee replacements were done in 2005/06. This is an increase of 17% in the 2005/06 compared to 2004/05 and more than 100% from 1995/96 to 2005/06 (Canadian Institute for Health Information, 2007). Newfoundland and Labrador has observed a ten year increase of just over 80% in the numbers of hip replacement surgeries performed between 1995/96-2005/06 and a 177% increase in the numbers of knee replacements performed in the same time period (Canadian Institute for Health Information, 2007). Arthritis is known to increase in prevalence as people age and because the population of Canada in general, and Newfoundland and Labrador in particular is aging (Statistics Canada, 2005), it is expected that the number of TJR procedures will continue to increase due to this and other factors such as the cost-effectiveness of the surgery (Dunbar et al., 2009). In addition, due to the increasing numbers of the last few decades, and the fact that joint replacements can fail over time, there will be an increased need for revision surgery to replace those replacements that fail (Dunbar et al., 2009) which will add greater pressure on the health care system with respect to wait times for such surgeries.

In 2004, Canadian First Ministers met and identified five key areas of importance for wait time reduction. Joint replacements were listed as one of those priority areas, along with cancer, cardiac procedures, diagnostic imaging and sight restoration. One of the goals arising from the meeting of the First Ministers was for all provinces to reduce wait times among the identified priority areas by the end of March 2007. Coming from this meeting, an increased focus on wait times, with nationally established benchmarks were identified with the expectation that the procedures would be performed within the benchmark in each area. Newfoundland and Labrador reports on its wait times in those areas every quarter through news releases from the Ministry of Health and Community Services. Information in those news releases presents the percentage of people that have received their joint replacement within the nationally established benchmarks. However, these nationally established benchmarks as well as the provincially reported wait times do not take into account the amount of time that patients are experiencing before they are placed on the wait list.

1.2 Rationale

This is a population-based retrospective cohort study of patients who have undergone total joint replacement surgery of the hip or knee (TJR). Total wait time is defined and measured and comparisons are done between those who have had shorter wait times to those who have had longer wait times to see if they differ from each other with respect to the incidence of coexistent disease or health service utilization. Information gained from this study gives a clearer indication of the total wait time patients in Newfoundland and

Labrador experience for TJR surgery and whether this impacts on health status (as measured by number of comorbidities and health service utilization).

1.3 Objectives

1. To describe the patients' wait time for total joint replacement surgery from referral to procedure, for all individuals undergoing TJR in the eastern region of Newfoundland and Labrador from 2002-2005.
2. To examine the number and the change in comorbidities that individuals experienced while waiting for TJR.
3. To investigate whether prolonged wait times were associated with a higher number of new comorbidities or greater utilization of health services, including length of stay in hospital after the replacement.

1.4 Outline

Chapter 2 summarizes current research on wait times and/or total joint replacement including a description of joint replacements, definitions of wait lists and wait times including recommended and current wait times across Canada. The impact of wait times is discussed by summarizing the research conducted on the effect of waiting for TJR surgery on outcomes after surgery. Included in this is a discussion of comorbidities, of the effects of a patient's preoperative condition on outcomes and an overview of using administrative databases and health service utilization. Chapter 3 outlines the

methodology used in conducting this research including a description of the data source, study population, independent and dependent variables, and methods used for analysis. Chapter 4 presents the results which include a description of the study population, an analysis of real wait times of the study population, as well as factors associated with short and long wait times in Newfoundland and Labrador. The chapter concludes with an analysis of the health trajectories of those waiting for total joint replacement surgery and examines the extent to which health care utilization variations are associated with longer wait times. Chapter 5 follows with a discussion of the results with comparisons and contrasts to previous work in this area. Chapter 6 concludes with a summary of findings and conclusions, a discussion of the strengths and limitations of the study and a discussion of possible future work in this area.

CHAPTER 2

LITERATURE REVIEW

The primary goal of this chapter is to review and summarize the Canadian and international evidence identified in the literature regarding wait times and the research around the impact of waiting for elective surgery. It begins with a description of what a total joint replacement (TJR) is and the definition of wait times and wait lists. Next, a summary of recommended wait times across Canada as well as the current reported wait times across Canada are presented. A review of the research to investigate the impact of waiting for total joint replacement follows and the chapter concludes with a section discussing the use of administrative databases for the purposes of health research.

A comprehensive literature review was carried out to identify articles associated with investigating wait times for TJR surgery and the impact of such wait times. Article search and retrieval included a broad review process whereby relevant studies were identified based on specific search terms such as "joint replacement" and "wait times" related to the research question. An academic librarian was consulted and through this, search terms and strategies were identified. When searching within Pub Med, terms were used to generate lists of search terms which were also "exploded" to include other related terms. Through use of this technique other relevant search terms such as "arthroplasty, replacement" and "waiting list" were incorporated into the search from the Medical Subject Headings (MeSH) tree to retrieve additional relevant articles. The literature

search strategy was constructed to include index search terms. In addition, additional literature was identified by reviewing references of the articles.

2.1 What is a total joint replacement (TJR)?

A total joint replacement occurs when a damaged joint (knee, hip, elbow, or shoulder) is removed and replaced with a prosthesis (an artificial joint). A total joint replacement is performed to decrease pain and/or increase mobility of a joint that has been damaged due to arthritis (March et al., 2002). For the purposes of this study, total hip replacement (THR) or total knee replacement (TKR) are the procedures of interest. It is known that over time a TJR replacement can fail and revision surgery may be needed with the life span of a replacement estimated at approximately ten to 15 years (McAuley, Szuszczewicz, Young and Engh, 2004; Mehrotra, Remington, Naimi, Washington and Miller, 2005).

With more than 90 percent of patients reporting significant relief in the amount of pain experienced, the effectiveness of TJR has been well established (Fortin et al., 1999). The cost-effectiveness of TJR has long been documented as well with TJR being recognized as one of the most cost-effective surgeries performed when looking at improving quality of life and costs saved by improving function of the affected joint (Chang, Pellisier and Hazen, 1996; Hawker et al., 2009). However, there is a problem of trying to decide the optimal timing of surgery. Performing surgery too early may result in the need for higher numbers of revision surgery as the replacements are known to fail over time. Leaving it

too late will cost more in treating the symptoms, as well as the direct costs (such as prescriptions) and indirect costs (such as loss of earnings) to the person involved. Canada has no set guidelines to say when surgery should be done (Sanmartin et al., 2000). Often, surgery is performed only when the pain is severe and function is very limited, but it has been questioned whether this is the most effective. In cases where the decision to have the procedure is followed by time spent waiting on a wait list, the pain may increase and functional ability may deteriorate even further, leading to a lower health related quality of life. This can lead to problems associated with a lack of exercise due to the patients' limited mobility. Philbin, Groff, Ries and Miller (1995) found that those with severe osteoarthritis are often considerably out of shape due to the immobility associated with the disease, leading to an increase in the risk of coronary heart disease. Because of findings such as this, one of the main objectives of this research is to identify comorbidities associated with a prolonged wait for TJR.

2.2 Definitions of Wait Times and Wait Lists

In a publicly funded health care system such as the one that exists in Canada, wait lists for elective procedures are common. Wait lists occur when the number of people needing the procedure is greater than the availability of resources needed to provide the surgery (e.g. surgeons, anesthesiologists, and operating room time). Wait lists are not always seen as a negative thing, for example, some people who are waiting may decide not to go through with the procedure, or the condition of others may improve so that they no longer require the procedure. In these cases, delayed access can allow people to back out, or

modify health behaviours resulting in a reduced need for the procedure, therefore opening spaces for others. However, arthritis is a degenerative disease and the possibility of improvement, as defined by an increase in functional ability and/or decrease in pain for example, after the disease has been diagnosed is rare (Dieppe, Cushnaghan, Tucker, Browning and Shepstone, 2000)

There are no Canadian standards in place regarding how wait times should be measured and reported. In some cases, as it is in Newfoundland and Labrador, the percentage of people receiving treatment within a certain amount of time is reported. Other measures including the median wait time, the mean wait time, or the wait time in which most people receive the treatment are also used to assess a health system's capacity to meet demand. In addition, the time measured is not always the same. For example, some areas measure time from decision to treat (by surgeon and patient) to surgery, others from date of booking until surgery, and others from last major consult to surgery. Therefore, it is clear that it is difficult to compare across provinces (and in some cases even within provinces) if both the way in which the wait time is measured and the way in which it is reported differ.

2.2.1 Recommended Wait Times across Canada

In 2004, First Ministers developed a ten-year plan to strengthen health care in Canada, which identified the importance of improving access to health care in a timely manner. Out of this came a recommendation that all regions in Canada would have to provide

updates on how long people wait for certain procedures, of which TJR was one identified area. Canada has invested resources to determine the maximum amount of time a patient should have to wait for their TJR, by developing medically acceptable wait times through the Wait Time Alliance of Canada (Eggertson, 2005). The Wait Time Alliance of Canada was formed by national specialty societies due to the long wait times encountered for certain procedures. The Wait Time Alliance recommended a wait time for TJR surgery of no more than three months for a consult with a specialist and no more than six months after the consult for the surgery (WTA, 2005).

Another such recommendation comes from the Health Minister Benchmarks released in December 2005, where it is recommended that patients should receive their surgery within 26 weeks after consultation with a specialist (Health Canada, 2006). The Western Canadian Wait List Project has released recommendations based on the patients' level of urgency where they recommended that the most urgent should receive their surgery within four weeks, those with a medium level of urgency within 12 weeks and the lowest urgency levels should have their surgery within 20 weeks (WCWL, 2005).

2.2.2 Current Reported Wait Times across Canada

The Fraser Institute annually releases a report based on a survey of physicians from 12 medical specialties (plastic surgery, gynecology, ophthalmology, otolaryngology, general surgery, neurosurgery, orthopedic surgery, cardiac and vascular surgery, internal medicine, urology, radiation oncology and medical oncology) on their wait times. The

18th edition of Waiting Your Turn: Hospital Waiting Lists in Canada reports on the wait times by province for each step of the wait using data collected from January 8 to April 18, 2008 (Esmail, Hazel and Walker, 2008). Overall in Canada, the survey found that the wait to see an orthopedic surgeon after referral is the second longest at 16.9 weeks out of all specialists surveyed (the longest wait was for neurosurgery at 19.4 weeks) and the wait from specialist to procedure is the longest for orthopedic surgery at 19.8 weeks for a combined total wait of 36.7 weeks. Also, Newfoundland and Labrador was found to have the longest waits for specialist consultations at 13.3 weeks. Table 1 shows the most recent wait times for all surveyed specialties across Canada according to national waiting list survey of physicians. Due to a low response rate, at 20% of physicians surveyed in Newfoundland and Labrador (Esmail et al., 2008) the results of the physicians surveyed have been criticized. However, because they are another source of information regarding wait times in Canada, it is still worthwhile to refer to their findings.

Table 1. Wait times by province for all surveyed specialists, 2008, adapted from Fraser Institute, 2008 (Esmail et al., 2008).

Province	**Referral to Specialist (weeks)**	**Specialist to Procedure (weeks)**	**Total Wait Time (weeks)**
British Columbia	7.1	9.9	17.0
Alberta	9.1	9.4	18.5
Saskatchewan	12.7	16.1	28.8
Manitoba	7.7	9.5	17.2
Ontario	7.0	6.3	13.3
Quebec	9.4	9.3	18.7
New Brunswick	12.0	11.1	23.1
Nova Scotia	12.2	15.4	27.6
Prince Edward Island	11.2	13.2	24.3
Newfoundland and Labrador	13.3	11.1	24.4

The Canadian Institute for Health Information (CIHI) has been involved in reporting on wait times across Canada for specific areas since 2005. Each year, the reporting of wait times becomes more comprehensive; however, comparing from province to province is still not suitable given that the definitions of that wait times may vary. Nevertheless, the summary report is still useful in tracking variations in waits over time, and eventually, if a consensus is reached on the definition of waits, then comparisons across provinces will be possible. Table 2 shows the most recent reported wait times by provinces as reported by CIHI (2009).

Because of the differences in reporting by province and by organization, it is difficult to draw any conclusions from the Table 1 and Table 2. In addition, based on the information presented, there does not appear to be a consistent standard or consensus for interpreting how long is too long for patients to have to wait.

Table 2. Joint replacement wait times by province, April to September 2008, adapted from CIHI, 2009.

	Exceptions to the Definition and Population	50th Percentile		90th Percentile		Percent Within Benchmark of 182 days		3-Year Trend*	
		Hip	Knee	Hip	Knee	Hip	Knee	Hip	Knee
N.L.†	Data are for Jan-Mar 2008 Benchmarks reported regionally only Excludes bilateral joints					79%–100%	67%–100%		
P.E.I.‡	Data are from Oct. 1, 2007, to Mar. 31, 2008	110 days	108 days	356 days	345 days	71%	75%		
N.S.		201 days	213 days	642 days	647 days	45%	46%		
N.B.	Includes all ages Includes only primary and unipolar hip replacements, primary knee replacements Bilateral replacements are counted as two operations	140 days	167 days	309 days	408 days	66%	55%		
Que.						90%§	86%§		
Ont.	"Patient unavailable" days are excluded from the wait time calculation Includes partial knee replacements	63 days	71 days	180 days	223 days	90%	85%	↓	↓
Man.	Includes out-of-province patients Includes hip resurfacing	110 days	121 days	245 days	312 days	80%	71%	↓	↓
Sask.	Based on data up to Nov. 24, 2008	155 days	246 days	482 days	616 days	56%	37%	■■	↓
Alta.		103 days	123 days	255 days	299 days	77%	72%	↓	↓
B.C.	Includes all ages Includes partial knee replacements	71 days	102 days	279 days	332 days	78%	71%	↓	↓

Legend

□ Data are not available.
▨ Unable to comment on trend data
■■ No change in wait times.
↓ Wait times decreasing.

Notes

* Trend is based on information gathered from provincial websites on December 1 of each year, from 2005 to 2008.
† Data for the Labrador-Grenfell Regional Health Authority were suppressed due to the small volume of cases completed in this quarter.
‡ For eight cases, the date of signed consent was substituted for missing received/booking dates.
§ Quebec data were obtained from www.msss.gouv.qc.ca/en/sujets/organisation/waiting_lists.html on December 1, 2008.

2.3 The Impact of Waiting and Outcomes following surgery

There are mixed findings with regard to the impact of wait times on patients waiting for TJR. The mixed results may be due to what is being measured (for example, health related quality of life versus health services utilization), how it is being measured (for example, self reported data on questionnaires versus administrative data through hospital and physician databases) and the definition of the wait time (for example, time on the wait list, time waiting to see a specialist or time before getting placed on the wait list).

One effect of waiting for surgery is the increase in costs both to the individual as well as to the health care system. An economic evaluation using information obtained from a literature review found that with respect to revision surgery, performing surgery sooner is likely to cost less to the healthcare system (Saleh, Wood, Gafni and Gross, 1997). In a study that followed patients while they were waiting for TJR surgery in New Zealand, it was found that patients waiting six months or more incurred a one and a half times greater cost than those waiting less than six months ($p<0.01$). The types of costs measured include economic costs (for example, prescription drugs, physiotherapy), personal costs (nonprescription medications, out of pocket costs, such as travel for doctor's visits and home help), and societal costs (time off work, time away from usual activities and reduced productivity) (Fielden et al., 2005).

Most research looking at the effects of waiting for TJR surgery has focused on measuring the patients' health related quality of life (HRQoL). This is typically done with the use of

questionnaires to measure the patients' level of functioning as well as their ability to perform regular daily activities when placed on the wait list, and again some time after the surgery has been done. Then comparisons are made to see if there has been an improvement, and whether the improvement is associated with the length of time spent waiting for surgery. In addition, looking at a patient's volume of health services utilization, (for example, the number of physician visits and/or hospitalizations over a one year period) can also be used to measure the health impact of waiting for TJR surgery. For example, looking at a patient who waits a longer period of time for their surgery can be found to differ in the number of physician or hospital visits over that one year when compared to patients who get their surgery sooner. Another way to look at how patients are impacted by waiting for TJR surgery is to compare the number of comorbidities for those who wait a shorter amount of time to those who wait a longer amount of time.

2.3.1 Health Related Quality of Life While Waiting

Various standardized questionnaires have been used in measuring a patients health related quality of life (HRQoL). For the purposes of this review, I limited the review to only the WOMAC, SF-36, 15D, Oxford Hip Score (OHS) and EQ-5D as they tend to be used most frequently for patients undergoing TJR surgery.

The WOMAC, the Western Ontario and McMaster Universities Index of Osteoarthritis, is an instrument that was designed specifically for use on patients with knee and hip osteoarthritis. Scores are given based on answers to questions about pain, stiffness, and

function of the affected joint (Kelly, Voaklander, Johnston, Newman and Suarez-Almazor, 2001). The SF-36 is the Medical Outcomes Short Form health survey with 36 questions used to measure general health status. Questions examine emotional role functioning, mental health, vitality, general health perception, social functioning and bodily pain. (Ostendorf et al., 2004) The 15D is a general instrument that measures HRQoL based on 15 dimensions such as a patient's ability to move, sleep, eat, perform usual activities, as well as their level of mental function, discomfort, depression, and distress (Hirvonen et al., 2006).

The Oxford Hip Score is tool that was designed specifically for total hip replacement. It contains twelve questions that assess pain and functional ability of the hip with respect to how the patient can perform daily activities (Ostendorf et al., 2004). The EQ-5D (Euro-Quol-5 dimensions) is another questionnaire used to measure health status and quality of life. Questions on this are related to mobility, self care, usual activities, pain/discomfort and anxiety/depression. When looking at health care costs however, the EQ-5D has been shown to be the preferred tool (Fielden et al., 2004). Many studies involving patients undergoing TJR surgery combine the WOMAC with one of the other instruments to get a broader picture of the patients' HRQoL.

As stated above, there are no consistent results when studies have looked at the effects of waiting for TJR surgery. Some studies have found no effect of waiting (Hirvonen et al., 2006; Kelly et al., 2001), while others have found a deterioration in HRQoL over the time

spent waiting (Fielden et al., 2005; Ostendorf et al., 2004). It has been commonly noted that patients waiting for TJR surgery are likely tolerating pain and disability while they wait. Often, prospective studies are done to look at the effects of waiting however, one downfall of a prospective study is that it is more difficult to involve large numbers of patients, therefore the sample size for many of those studies are small.

A prospective study performed in Alberta, Canada followed 313 patients from the start of placement on the wait list until surgery to look at the extent to which HRQoL of the patients deteriorated while they were waiting. The pain and disability of patients at the start of their wait and within five days before surgery was assessed with the use of the WOMAC and SF-36. The patients in this study waited an average of 4.5 months with 30% (n=94) waiting less than three months, 42% (n=131) waiting between three and six months and 21% (n=66) waiting more than six months. No increase in pain or deterioration in functional ability was found while the patients waited, however the pain and functional ability scores were found to be low overall, indicating a high level of pain and a limited functional ability that the patients had to endure during their wait (Kelly et al., 2001). These findings were supported by Hirvonen et al. (2006) who followed patients on a wait list for TJR in Finland and compared them over time as well as to a matched control group to see whether their health related quality of life (HRQoL) decreased. The 15D instrument was used to measure patients at the time they were placed on a wait list and again at the time of admission for TJR. It was found that there were no decreases in any measures of HRQoL while the patients were waiting. A significant

difference was found in the baseline scores of the TJR patients and matched controls, but these differences existed before the patients were placed on the wait list. Also, slightly more than 70% of patients (n=94) in this study received their surgery within three months and less than 15% (n=19) had to wait more than six months. For both of those studies, small sample size as well as short wait times are limitations. It is also possible that any decreases in HRQoL may have already occurred by the time the patients were placed on the wait list. This gives more evidence to support looking at the time spent waiting before placement on a wait list.

Because it was recognized that waiting for TJR surgery often begins before being placed on a wait list, Mahon et al. (2002) followed patients in Ontario who were referred to a surgeon until at least three months after TJR surgery. Fifty percent had surgery within 4.7 months (n=50), 25% (n=25) waited between 4.8 and 8.2 months and 25% (n=25) waited from nine to 24 months. The average time waited to see the surgeon after the referral was 3.2 months. No differences were found between wait time and the HRQoL after the surgery. However, it was found that those patients who waited more than six months did lose some mobility and HRQoL while they waited. Patients who waited six months or less (n=63) were found to have greater improvements in their HRQoL after surgery than those who waited more than six months (n=36, $p<0.01$). Therefore, those who had longer wait times did not have a significant difference in HRQoL after their surgery when compared to those with shorter wait times, but they did show decreases in the measures of HRQoL and functional ability while they waited for TJR.

Other studies have shown a deterioration in HRQoL by looking only at the wait time (defined as the time when both the physician and patient agree to the surgery until the surgery occurs). A prospective study in the Netherlands followed 161 patients at the time they were placed on the wait list for TJR surgery until the surgery, using OHS, WOMAC, SF-36 and the EQ-5D. The average wait time for patients in this study was approximately 6 months with 29% (n=47) waiting less than three months, 24% (n=38) waiting between three and six months and 47% (n=76) waiting longer than six months. A significant decrease in scores was found while patients were waiting ($p<0.01$), and multiple regression showed that wait time was the only predictor for a decrease in HRQoL scores. Other predictors examined were gender, age, comorbidity and socioeconomic factors (Ostendorf et al., 2004). Similar results with respect to an association between HRQoL and wait time were found during a prospective study in New Zealand. The WOMAC and EQ-5D were used to measure functional ability at the time patients were placed on the wait list, as well as every month before surgery and every month after surgery for six months. The average time spent waiting was 5.1 months with 40% (n=49) waiting less than three months, 33% (n=41) waiting between three and six months, and 26% (n=32) waiting more than six months. Both instruments found a significant decrease in HRQoL while the patients were waiting, $p<0.01$ (Fielden et al., 2005).

2.3.2 Comorbidities

Comorbidities, sometimes referred to as coexisting diseases, are any conditions that a patient may have in addition to the disease of interest. As people age, chronic conditions

are known to increase in prevalence, and because TJR surgery typically occurs among patients above the age of 50, it is not uncommon for patients waiting for TJR surgery to have at least one comorbidity (Raina, Dukeshire, Lindsay and Chambers, 1998). In addition, patients with arthritis have been shown to have higher risks of developing other chronic conditions than patients without arthritis when matched by age and sex (Gabriel, Crowson and O'Fallon, 1999). Verbrugge, Lepkowski and Imanaka (1989) looked at comorbidities using the 1984 Supplement on Aging by determining the number of comorbidities among people in the study. The 1984 Supplement on Aging was completed by the National Center for Health Statistics (NCHS) and the National Institute on Aging (NIA) in the United States and was done to describe the health status of people over the age of 55 in the United States (Fitti and Kovar, 1987). It was found that having a higher number of comorbidities was associated with more disability and this was found to be a more important predictor of a patient's level of disability than their age.

Patients waiting for TJR surgery have a certain amount of pain and functional disability that often limits their level of physical activity. Therefore, spending a prolonged period of time waiting for TJR surgery with this limitation may have lasting effects by increasing their risk for developing other chronic conditions such as cardiovascular disease or Type-II diabetes. Many of those chronic conditions are known to increase in prevalence due to a lack of physical activity. The importance of maintaining an active lifestyle on the reduction of risk for chronic conditions such as cardiovascular diseases and diabetes has been recognized. For example, a large study done in Great Britain followed more than

7,000 men for more than ten years and found that the participants who were less active had a five times higher risk of mortality due to cardiovascular disease when compared to participants who were moderately active (Wannamethee, Shaper and Walker, 1998). Also, a study done at the University of Pennsylvania followed close to 6,000 men for fourteen years and found that physical activity was significantly associated with a decreased risk of Type 2 diabetes (Helmrich, Ragland, Leung and Paffenbarger, 1991).

Comorbidities among people waiting for TJR surgery have been measured in various ways, each having benefits and disadvantages. A common approach has been to use the Charlson comorbidity index. This instrument concentrates on 17 conditions and takes into account the number of conditions a patient has and the severity of each by weighting conditions differently according to physician's judgments. This instrument was designed to predict mortality in a group with a moderate risk of mortality and a low level of morbidity. Because patients waiting for TJR surgery do not fit these criteria, this index has been said to be limited in its use with this group of patients although it does measure the burden of the conditions (Gabriel et al., 1999). The Index of Co-Existent Disease (ICED) was designed to address the limitation of the Charlson Index, because it was designed to predict functional ability among patients with a low risk of mortality, which is more representative of patients waiting for TJR surgery. This index does take the severity of each condition into consideration, as well as how much disability each condition has caused, however special training is required in order for it to be used (Gabriel et al., 1999). Because of the limitations of the Charlson Index and the difficulty

in using the ICED, many studies have chosen to study comorbidities by simply summing up the number of comorbidities (Ayers et al., 2005; Davis et al., 2006; Klabunde, Warren and Legler, 2002; Tuominen et al., 2007; Wasielewski et al., 1998). This approach is simple to implement but has the disadvantage of treating all comorbidities as the same.

Young, Cheah, Waddell and Wright (1998) performed a review of the literature from 1966 to 1998 and found that comorbidities can have a negative effect on outcomes such as functional ability after TJR surgery. In addition, a study done in the United States, looked at hospital data for 356 patients from four hospitals that had TJR surgery. It was found that with the use of the ICED, patients with moderate comorbidity were three times more likely to have a complication after the surgery (95% CI 1.5-6.4) (Greenfield, Apolone, McNeil and Cleary, 1993). These findings were also supported by Davis et al. (2006) who conducted a prospective study following 126 patients in Toronto and found that two years after TJR surgery, those patients with fewer comorbidities had better functional outcomes ($p<0.05$) as measured by the WOMAC.

Patients with comorbidities often have to endure greater wait times for TJR surgery, as the surgery may not be done unless the chronic conditions are under control. Therefore having chronic conditions can contribute to the length of the wait time. Comorbidities are typically measured as a patient characteristic and not as an outcome. However, it is possible that spending a long period of time waiting for TJR surgery can increase the likelihood of patients developing other chronic conditions. This would provide evidence

for the importance of more timely surgery. This will be examined in the chapters that follow.

Longer waiting with osteoarthritis means a longer period of time that individuals are limited in the activities of daily living. The overall medical condition is then affected (Garbuz, Xu, Duncan, Masri and Sobolev, 2006) and can lead to higher risks of comorbidities due to the patients' physical inactivity (Philbin et al., 1995). A long wait time will also result in a prolonged amount of time that a patient will have to use non-steroidal anti-inflammatory drugs that have been proven to increase the risk of gastrointestinal problems (Belsey, 2003). In addition, it is thought that patients with arthritis that have comorbidities have higher disability than patients who have the same conditions that do not have arthritis (Verbrugge et al., 1989; Verbrugge, Lepkowski and Konkol, 1991). Therefore, reducing the amount of time spent waiting for total joint replacement surgery can enable the patient to become more physically active and may put them at less risk of developing other chronic conditions.

2.3.3 Effect of preoperative conditions on TJR outcomes

As described above, many studies examining the effect of waiting for TJR surgery have focused on whether there is deterioration in HRQoL during the wait time. What has often been reported is there is no significant decrease in HRQoL during the wait time. Instead patients' pain levels and functional ability before the surgery has been found to have an impact on how well they fare after the procedure. Therefore, even when wait time is

found to have no effect on outcomes, the preoperative functional status has been shown to have an effect (Nilsdotter and Lohmander, 2002; Ostendorf et al., 2004).

One way the impact of preoperative condition has been measured is by comparing people on the wait lists in one country to those on wait lists on another country, as it has been shown in these studies that the both the wait list system (due to public versus private health care) and the preoperative status of patients differ between countries. Both Fortin et al. (1999; 2002) and Lingard et al. (2004) have undertaken this approach which allows for comparisons of those who are able to receive their surgery sooner due to the health system versus those who have to endure time on a wait list. A prospective study by Fortin et al. (1999) compared patients from a hospital in Montreal, Canada to one in Boston, United States (which is a mix of public and private funded care). A total of 220 patients were asked to complete both the WOMAC and SF-36 preoperatively and at three and six months after the surgery. Patients from the Canadian hospital were found to be more functionally impaired at the time of surgery than the patients from the US hospital; more than three quarters (77%) of those from the US hospital and less than one quarter (23%) of those from the Canadian hospital were considered to be at high function (according to the WOMAC and SF-36) at the time that surgery was booked. It was found that after surgery, those who had a lower preoperative functional ability, regardless of the hospital, did not reach the same functional level as those who were less functionally impaired before surgery. A multiple regression found that baseline scores were the most significant predictor of postoperative scores. Other predictors examined were age, sex, hospital,

education and comorbidity. In the two groups, the wait time itself was similar, suggesting that the differences occurred before the patients were placed on the wait list, and it was suggested that those in the Canadian hospital received their surgery at a later stage of the disease than those in the American hospital. This study concluded that TJR surgery performed when the functional status has deteriorated leads to a worse outcome. A follow up to this study in 2002 looked at the same patients two years after the procedure and found that the poor outcomes for those with worse preoperative functional status continued even two years after surgery (Fortin et al., 2002).

A similar result was found by Lingard et al. (2004) who compared patients from the United States, United Kingdom and Australia and found that those in the United Kingdom were in worse condition before surgery. That group was also found to have the largest wait times for both the orthopedic consult as well as the surgical wait list. It was found that the most significant predictor of low post-operative scores (worst functional ability) were low pre-operative scores on both the WOMAC and SF-36. Other predictors examined include age, sex, income, education, working status, body mass index, comorbidity, country and hospital. Those with lower functional ability and/or severe pain before surgery were more likely to have worse outcomes at one and two years after surgery ($p<0.05$). Patients that fell into the worst 25% of scores on the WOMAC were found to be more likely to have a low score at two years after surgery than those patients who had a better WOMAC score before surgery with an odds ratio of 4.12 (95% CI 2.86-6.25).

Investigating whether a patient's preoperative status has an impact on outcomes leads to discussions of cost-effectiveness. In a public health care system, the decision to perform elective surgeries is often made with the goal of doing the surgery at a time when it would be the most cost effective for the health care system. March et al. (2002) obtained information on costs for 174 patients in Australia and found that patients with worse functional ability and more pain, as measured by the WOMAC and SF-36 before surgery had more costs in the year after surgery than those who had better preoperative function ($p<0.05$). It was found that for every point increase in function score or decrease in pain score (which signified worse functional ability and increased pain), the cost increased by 103% and 96%, respectively. The costs measured include out-of-pocket costs (for example, medications, special equipment, household alterations and any home assistance that was required) which were measured by patients' cost diaries, and health care utilization costs (for example, visits to physicians, physiotherapy, diagnostic tests and any community services that were not paid for by the patient).

A similar study was done in New Zealand by Fielden et al. (2005), who followed 122 patients and measured costs by patient diaries that documented medical procedures (to measure costs to the health system), out-of-pocket costs and costs associated with time off work, paid help and other social costs. It was found that waiting had an effect on the preoperative functional status as discussed previously. It was also found that waiting led to higher costs for the patients; those patients who waited six months or more for surgery were more likely to have higher costs, with an odds ratio of 2.40 ($p<0.05$).

Ethgen, Bruyère, Richy, Dardennes and Reginster (2004) reviewed the literature from 1980 to 2003 and concluded that those patients with the worse HRQoL scores before surgery benefit the most from surgery. This is based on the finding that the improvement in scores is higher for those who are more disabled and in more pain before surgery than among those who have better functional ability and less pain (Ethgen et al., 2004). However, what is not discussed is the fact that it has been shown that those in worse preoperative conditions do not improve to the same level as those who have better preoperative status. Although the total gain may be more, they often do not obtain the same results from surgery as those who have better preoperative functional ability. Because the goal is to perform surgery to obtain the most benefit for both the patient and the health system, often patients are not placed on a wait list for surgery until the level of pain is high and the functional ability is greatly compromised. If, however, they were placed on a wait list earlier, and surgery was performed more quickly, they may be less affected by the arthritis and have a better preoperative status. As preoperative status has been found to predict outcome, this may be something that should be considered when patients are placed on a wait list for TJR surgery.

2.3.4 Health Service Utilization

Measuring Health Service Utilization of patients while they are waiting for TJR surgery is another way of looking at the impact of waiting for TJR surgery. A limited amount of research exists that examines health services utilization for TJR patients. The focus for such studies tends to concentrate on HRQoL, which can only be captured by patient

survey. Measuring health services utilization for TJR patients adds an important piece to the overall picture of those patients while they are waiting for their surgery because patients with osteoarthritis often require a high level of health services (Ethgen, Kahler, Kong, Reginster and Wolfe, 2002). Health service utilization can be measured with administrative databases by looking at physician visits, hospital separations, onset of comorbidities, and length of stay after TJR surgery.

Looking at the length of stay following TJR surgery has been done in a small number of studies. One study, by Kreder et al. (2003) was done in Ontario and used four years of data to look at factors predicting outcomes after knee replacement. Mean length of stay was found to range from 10.0 days to 11.5 days depending on characteristics of the hospital and the patients. It was found that patients who had their surgery in hospitals with the least experienced surgeons stayed a significantly longer amount of time after their joint replacement than those patients who had their surgery in hospitals with the most experienced surgeons as reported by a 95% confidence interval. Older patients, females and those with higher number of comorbidities were also found to be associated with longer lengths of stay as reported by a 95% confidence interval when compared to younger patients, males and those with less comorbidity (Kreder et al., 2003).

A prospective study done in Australia looked at 65 patients who were having TJR surgery to determine how long patients stay in hospital after hip replacement. It was found that the length of stay varied from five days to 39 days with 60% (n=36) having a length of

stay of eight days or less. Those patients that had a length of stay of ten or more days were found to be significantly older (OR 3.92, 95% CI 0.55-27.8) and have higher numbers of comorbidities (OR 2.00, 95% CI 0.54-7.4) than those who were discharged by the eighth day (Wang, Ackland, Hall, Gilbey and Parsons, 1998). A similar mean length of stay was also found in a study done in four hospitals in the United Kingdom. 353 patients were found to have a mean length of stay of 9.5 days (Hayes, Cleary, Gillespie, Pinder & Sher, 2000)

While many studies have investigated length of stay after TJR, it has not been examined whether the amount of time people spent waiting for their surgery is associated with the length of stay after the procedure. Administrative data is a good resource for examining length of stay as this is something that is readily collected for the purposes of day-to-day health system management (Simunovic et al., 2005).

2.4 Using Administrative Data

Administrative databases contain data collected for the purposes of day-to-day management of services such as patient care and resource tracking. Because of the amount of information they contain, administrative databases are increasingly being used for research purposes. They are available electronically and are created to capture information in hospitals, physician offices, and other places where health care is provided. Because of improvements in information technology, storing and retrieving

information in those databases is less costly and less time consuming and offers many opportunities for population based epidemiological studies.

It has been shown that administrative databases can be used to measure wait times for various procedures. One study in Ontario, Canada set out to measure how long patients in that province waited for cancer surgery with the use of hospital and physician databases (Simunovic et al., 2005). In that study wait time was defined as the time from the preoperative consult with the surgeon until the date of admission to the hospital for the procedure. Similar studies have been done in both Quebec and Manitoba (DeCoster, Carriere, Peterson, Walld & MacWilliam, 1999; Mayo et al., 2001).

Hospital and physician databases can also be used to look at comorbidities in patient populations. In some studies, self reported comorbidities are used which can be biased, due to people not remembering all conditions, or being unsure of what they have been diagnosed with. Other studies use chart review to determine patient comorbidities. However, this has been shown to be costly and labourious, especially when dealing with a large number of patients. Instead, administrative databases have been used which can quickly provide information on very large numbers of patients. The conditions patients have during each hospitalization are coded and entered into the hospital database, and in the case of fee-for-service physician databases, the procedure or service provided to the patient is coded in order for the physician to be paid for that visit. Therefore, each of

these databases can be combined to produce a more complete picture of the patients' health trajectory during their wait time for TJR surgery.

However, the use of administrative databases does not come without limitations. Because they are used for billing/administrative purposes, there is often concern about the quality of the information they contain with respect to inaccurate or incomplete coding (Hawker, Coyte, Wright, Paul and Bombardier, 1997). In addition, most administrative databases do not indicate the severity of the diagnoses or include information about their HRQoL. To address these limitations, they may be used in combination with chart reviews or surveys. In addition, the use of multiple administrative databases, linked together with a unique identifier, can provide more information by tracking patients throughout the health care system and can yield informative findings on large patient populations with minimal resources.

2.5 Summary of Literature Review

The number of total joint replacements being performed in Canada increases each year. As more and more people require this procedure, wait times for this surgery are expected to increase. Decreasing the waits for this and other surgeries have already been recognized as important both by the federal and provincial governments in Canada. However, if the total wait that patients experience is not taken into account, there may not be a true reduction in the total wait time. Instead, there may be a decrease in time on the wait list, which may be offset with an increase in the wait to see an orthopedic surgeon or

an increase in the number of consultations with the orthopedic surgeon. Therefore, the total wait that patients experience should be considered. In addition, what happens to the patients while they are waiting should be taken into consideration to determine whether they may benefit from being placed in a higher priority group to receive their surgery sooner. Considerable research has been done to examine how waiting for total joint replacement surgery impacts a patient's health related quality of life, but limited research exists with respect to the health service utilization of such patients. Since patients with arthritis have been shown to have high rates of health service utilization and thus, to be more likely to have other chronic conditions, it is important to get a broad picture of those patients while they are waiting. Using administrative databases, this can be done by looking at the length of hospital stay after the replacement, the number of physician visits and hospital separations after referral to an orthopedic surgeon, and as well, the number of chronic conditions each patients have, and whether any new chronic conditions are diagnosed during the wait time.

CHAPTER 3

METHODS

This is a retrospective cohort study that involved secondary use of population-based administrative database in Newfoundland and Labrador. The purpose of this research was to determine the amount of time people in Newfoundland and Labrador were waiting for total joint replacement surgery and to examine whether prolonged wait times were associated with poorer health outcomes. Both the amount of time on the wait list and the time prior to being placed on the wait list after physician referral were measured to get a more accurate picture of the true wait time that the patients experienced. The impact of waiting on health outcomes was examined by measuring the comorbidities of patients both before the start of the wait time and after the wait time began to determine if patients developed more comorbidities while they were waiting. The number of physician visits and hospital separations was also measured before the start of the wait time and after the wait time began to determine whether patients had more visits while they were waiting than they did before the wait time began. The length of stay for the replacement was also measured to determine whether the length of the total wait time was associated with length of stay.

3.1 Data sources

Data sources were provided by Eastern Health (Surgery Department Data) and the Centre for Health Information (Physician Claims and Hospital data) and were linked together to get as comprehensive a picture as possible with the use of administrative databases.

3.1.1 Surgery Department Data

The Eastern Regional Integrated Health Authority (EH) provided surgery department data for the study. The provided data included information on patients who had a total joint replacement surgery at EH from 2002-2005. The file included unique provincial health insurance number (MCP number), type of replacement, date of procedure, and where available, the date patients were placed on the wait list and the corresponding number of days spent waiting. From 2002-2003, the surgery department did not capture wait list data, therefore for this time period, only type and date of procedure can be determined. From February 2003 to November 2005, wait list data is available and the date the patient was placed on the wait list can be determined for this group of patients. This file was provided to an employee of the Newfoundland and Labrador Centre for Health Information (the Centre) who removed patient identifiers and replaced the MCP number with a study ID before any analysis was completed.

3.1.2 Medical Care Plan (MCP) Claims File

This database consists of fee-for-service physician billing claims which contains demographic and clinical information on services provided to Newfoundland and Labrador residents by physicians. Information obtained from the database included age, sex, diagnosis, date of service, main service billed, and physician specialty code as well as the unique provincial health insurance number (MCP number) assigned to each individual patient. The specialty code classified the physician providing the service as a general practitioner or a specialist with each specialty assigned a different code. The

accuracy and completeness of the MCP claims file has not been verified, however because the information it contains is part of the claims for payment, it is considered to be complete in terms of number of visits and type of physician visited (e.g. general practitioner versus orthopedic surgeon) (Segovia, Edwards and Bartlett, 1997). It is important to note that salaried physicians do not submit claims for their services. Consequently, information about their patients is not contained in this database. However, because the individuals in this database received their service at EH, it is likely that they received their care from a fee-for-service physician, as the eastern region of NL has a higher percentage of fee-for-service physicians than other regions of the province (Segovia et al., 1997). Therefore, a claim for services was likely made to MCP.

Access to this database was provided through the Centre. Physician claims data was linked to the Surgery Department data by an employee of the Centre to extract information on fee-for-service visits of those individuals who have undergone TJR from 1995-2006.

3.1.3 Clinical Database Management System (CDMS)

The CDMS contains hospital separation data and is maintained by the Centre. All hospitals in the province submit discharge data to the Canadian Institute for Health Information (CIHI) on hospital separations. These data are provided to the Centre and the data quality checks are performed by CIHI and further verified by the Centre. This database captures demographic, clinical, procedural and provider data for acute care

(inpatient) and surgical day care discharges by MCP number. Each record represents a hospitalization and contains diagnostic information coded using the International Classification of Diseases (ICD). ICD versions nine (1995/96-2000/01) and ten (2001/02-2005/06) were used. Each unique hospitalization, admission and discharge date, diagnosis type and diagnosis code was extracted from the CDMS and linked to the Surgery Department data to obtain information on hospital separations for those individuals who have undergone TJR. Data from April 1, 1995 to March 31, 2006 were included in the study.

3.2 Data Linkage Process

Using a multi-step data linkage approach (Appendix A), the Surgery Department data was linked to the MCP database as well as the CDMS database via the patient's MCP number. The linkage was performed by staff at the Centre and each file was de-identified to remove any personal identifiers, leaving only a Subject ID as a unique identifier, before analysis was performed.

In March 2006 an application was submitted to the Human Investigation Committee (HIC) of Memorial University of Newfoundland asking for approval to use Surgery Department Data provided by EH and link it to the MCP Physician Claims Data housed at the Centre. In April 2006, HIC responded to the request suggesting that the CDMS data also be used to increase the amount of data and confidence in the diagnoses codes. The Centre was approached regarding both databases and a revised HIC application was

resubmitted with more focused objectives in May 2006. In July, HIC granted conditional approval requesting further information on years of data and in August 2006, full approval was given.

In September 2006 the process began, at the Centre, for the Privacy Impact Assessment and Data Sharing Agreement. In February 2007, data were made available by the Centre for Health Information and an employee of the Centre received the Surgery Department data and began the de-identification and linkage to the MCP Physician Claims data and the CDMS hospital separations data. In February, 2007, data was made available and the analysis began.

3.3 Study Population

All total hip replacement and total knee replacement procedures performed between 2002 and 2005, in the Eastern region of Newfoundland and Labrador were included in the study. From 2002 to 2005, there were 1,382 total joint replacement procedures in the Eastern Health region of Newfoundland and Labrador. If a patient had a second TJR during the study period the second procedure was excluded (139). Also, any individuals that could not be linked via the MCP number were also excluded (31) as no further information could be captured on those patients. The total number of TJR patients included in the study was 1,216.

3.4 Ethical Considerations

The study was approved by the HIC of Memorial University of Newfoundland on August 31, 2006 (Appendix B). This is the ethics committee responsible for reviewing research on human subjects in the province. An annual update was provided to the HIC on October 31, 2007. To ensure confidentiality and protect the privacy of study participants, all direct personal identifiers were removed prior to providing the linked data files.

Approval was also obtained from the Research Proposal Approval Committee (RPAC) of Eastern Health on October 27, 2006. This committee reviews all research projects that will involve Eastern Health to identify the resources required, the potential impact and to review whether the researcher will have access to confidential information. In addition to this, both a Privacy Impact Assessment and a Data Sharing Agreement were completed and provided to the Centre before the de-identified data was released to the researcher.

3.5 Study Variables

Information on wait times for the various components of the total wait (from referral date, first specialist visit, placement on the wait list and procedure date), as well as demographics (age, sex) and clinical information (diagnosis codes), were available. In addition, health service utilization (number of visits, length of stay) and comorbidities were determined for the analyses.

3.5.1 Wait Times

For the purposes of this study, the total wait time from GP referral to orthopedic surgeon until the procedure was taken into consideration. However, the MCP data did not provide the referral date. Because of this limitation, the wait list start date was taken to be the last visit to the GP with an arthritis diagnosis code before the first visit to the orthopedic surgeon. It is likely that this is an underestimation of the time waited to see the specialist as patients often see their GP while they are waiting to see the specialist; therefore the last visit is not necessarily the same date as the referral. This was similar to what was used by Simunovic et al. (2005); however they used the date of last consult before surgery as a proxy for the date that the decision for surgery was made.

The total wait time was divided into segments looking at the wait time from last general practitioner visit (with an arthritis code) to first orthopedic surgeon visit, and the wait time from first orthopedic surgeon visit until procedure. Also, where available, the time from first orthopedic surgeon visit until date placed on wait list as well as the measured wait list will also be broken down. The total wait time then becomes a series of smaller wait times (Figure 1).

Figure 1 describes the break down of the total wait time into the various segments of the wait. Wait Time I measures the time between the last GP visit with an arthritis diagnosis and the first specialist visit. Wait Time II can be broken into parts IIa and IIb in cases where the date of placement on the wait list is available. For those, Wait Time IIa

measures the time between the first OS visit and the date of placement on the wait list, and Wait Time IIb measures the time on the wait list captured by the surgery department. Where this data is not available, Wait Time II measures the time between first OS visit and the date of the TJR. Both the Total Wait Time (I + II), as well as each of the smaller steps (I, IIa and IIb) will be examined.

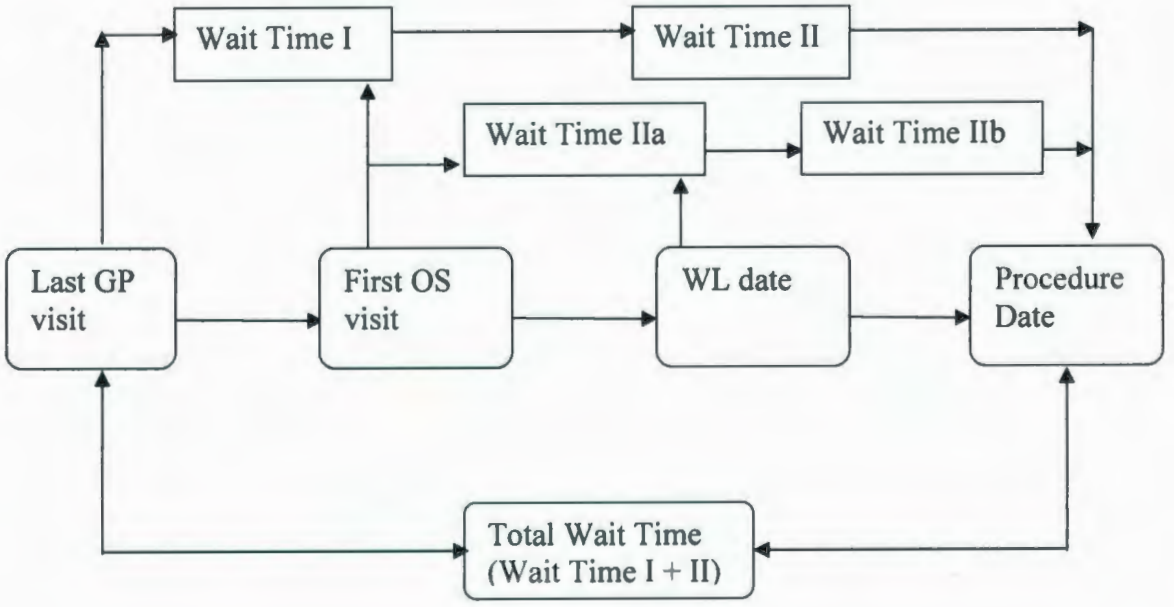

Figure 1. Diagram of the breakdown of wait times from referral to procedure.

Wait time exists as a continuous variable and has also been categorized into short, moderate, long and very long versus waits for the total wait time. A study done by Mahon et al. (2002) who also looked at time waited from referral by general practitioner to surgery categorized wait times into four groups; less than three months, three to six

months, six to twelve months and greater than twelve months. However, the wait times in this study were much longer, not allowing for this breakdown. In addition, because the nationally established benchmarks refer to time on an official wait list and not the total wait time discussed here, it was thought that the usage of those would not be appropriate, given the longer wait times for the total wait. Instead, short wait time was defined as less than 18 months, moderate as 18 to 48 months, long as 48 to 72 months and very long as greater than 72 months.

3.5.2 Demographic Factors

Patient sex – A dichotomous variable coded '0' for males and '1' for females.

Patient age – Age at the date of procedure was obtained from the MCP file. Age was grouped into four categories: less than 50 years, 50 to 64 years, 65 to 79 years and 80 years or older so that any categorical analyses could be performed. Age was also kept as a continuous variable ranging from 24-92.

Type of Replacement – A dichotomous variable coded as '0' for Total Hip replacement and '1' for Total Knee Replacement.

3.5.3 Health Service Utilization

Length of stay – Using the procedure date from the surgery department data and the diagnosis codes from the CDMS database, the unique hospitalization for the TJR was determined. Patients' length of stay after the TJR was then available from the CDMS database. Data was available for 1,202 patients and length of stay ranged from 2 to 157 days. Outliers were defined as anything greater than 100 days and four records (0.3%) were subsequently removed from the regression analysis.

Number of visits – Unique patients were grouped by the Subject ID. The number of fee-for-service visits, as well as the number of hospital separations were counted for the five years prior to the start date of the wait time (which was taken to be the last GP visit with an arthritis code before the first specialist visit). Because the use of five years before surgery and five years after surgery was not possible for the patients, analyses were performed using negative binomial regression. For negative binomial regression analyses, the limitation to five years prior to the wait time start and five years after the wait time start was not necessary as this analysis controls for the elapsing of time.

Number of new comorbidities – A list of common chronic conditions were determined based on studies that looked at comorbidities associated with arthritis and TJR (Wasielewski et al., 1998; Marks and Allegrante, 2002; Rosemann, Joos, Szecsenyi, Laux and Wensing, 2007a, Memtsoudis, Gonzalez, Besculides, Gaber and Laskin, 2008). This list of diagnoses was coded by a health information consultant from The Centre. Table 3

shows the list of comorbidities and the relevant ICD9 or ICD10-CA codes. Of that list, any new diagnoses that occurred during the patients' wait time were considered. If a diagnosis was made before the date of last visit to the GP with a diagnosis of arthritis, than that diagnosis was not considered to be "new". Any diagnoses that were recorded during the time from last GP visit with a diagnosis of arthritis until the procedure was considered to be "new". A count of new diagnoses was made by Subject ID to identify any new conditions that developed during the patients' wait.

Number of pre-existing comorbidities – Of the list shown in Table 3, any diagnoses that occurred before the start point of the true wait were categorized as a previously diagnosed comorbidity. If a diagnosis was made before the date of last visit to the GP with a diagnosis of arthritis, that diagnosis was considered to be "pre-existing". A count of pre-existing comorbidities was made by Subject ID to identify any conditions that the patients had before the wait began

Table 3. List of ICD-9 and ICD-10CA diagnoses codes to identify comorbidities

Condition	ICD-9 Code	ICD-10CA Code
Arthritis	712, 714-721	M00-M03, M05-M13, M15-M19, M45-M47
Asthma	493	J45
Cerebrovascular Disease	430-432, 434	I60-I64
Chronic Obstructive Pulmonary Disease (COPD)	490-492, 496	J40-J44
Chronic Renal Failure	585-586	N18-N19
Depression	296, 298, 300, 309, 311	F313-F315, F32-F34, F381
Diabetes	250	E10-E14
Heart Failure	428	I50
Hypertension	401-405	I10-I12, I13, I15
Ischaemic Heart Disease (IHD)	410-414	I20-I25
Peripheral Vascular Disease	440	I70, I73
Phlebitis/Thrombophlebitis	451, 453	I80
Stomach/Intestinal Ulcers	531-534	K25-K28

3.6 Data Analysis

Analyses were performed using SPSS 15.0 statistical software (SPSS Inc., 2006) and STATA 10.0 software (StataCorp, 2007). The study population was described according to patient sex and age at time of procedure, and by type of procedure. Wait times for each step of the wait as well as number of visits (physician and hospital), number of comorbidities (new and pre-existing) and length of stay were described. To identify any differences in means of continuous variables, *t*-tests and ANOVA were used. The chi-square test was used to test for associations between wait time group and the demographic variables as well as number of comorbidities.

A Multiple linear regression was done to look at whether there was any association in length of stay by age, sex, type of replacement, wait time, number and type of visits, or number of comorbidities. Length of stay was log-transformed to provide the best approximation to a normal distribution. Outliers have been defined as any observations that fall outside three standard deviations of the mean (Mendenhall and Sincich, 2003). However, to minimize the chance of removing any observations that should not be removed, it was decided to remove only those observations with a length of stay after TJR surgery of 100 days or greater. This resulted in the removal of four (0.3%) observations. It was decided to remove those observations for the purposes of the linear regression because by observing the length of stay for the patients, it seemed very likely that when a length of stay after TJR became longer than 100 days, other factors are assumed to be responsible and therefore these likely are not a true length of stay due to a TJR. For example, it may be a patient has an increased length of stay while they are waiting for admission to a long term care facility.

To observe the effect on the number of hospital separations, physician visits and comorbidities, the analysis had to adjust for time. It is obvious that the longer someone waits, the more likely they are to have a higher number of hospitalizations and/or physician visits as well as a higher chance of developing a comorbidity. One common approach used to analyze data that involves looking at counts over time is a Poisson regression. Such an analysis adjusts for the period of elapsed time so that any differences will not be impacted by the amount of time that has passed (Winkelmann and

Zimmermann, 1995). However, a Poisson regression requires the variability of counts to be less than the mean. When this is not the case, the data is said to be over-dispersed (variance greater than the mean) or under-dispersed (less variation than predicted). There is an extension to Poisson regression, the negative binomial regression, which can account for greater variation in the data. (Hilbe, 2007) Because data were found to be over-dispersed, the negative binomial regression was performed.

CHAPTER 4

RESULTS

4.1 Introduction

The results are presented in three sections. The first section describes the study population, the wait times and also the health service utilization by patient sex, age and type of replacement. The second section of the results describes the differences among the various wait time groups and the third section looks at the impact of wait times on health service utilization and comorbidities.

4.2 Description of Study Population

The Surgery Department data contained 1,399 patient records. Of those records, 13 were removed because they were partial replacements, 31 had invalid MCP numbers and were removed because they were unable to be linked to the other databases, and 139 were excluded because they were second procedures for the same patients. This resulted in 1,216 unique patients. Of those 1,216 records, age and sex was available for 1,209 patients. Data pertaining to wait times were available for 713 patients. For regression analyses involving length of stay, four records with length of stay of 100 days or greater were deemed to be outliers and removed.

Table 4 describes characteristics of the study population. More than half (58.1%) of the individuals in the study were female; just over half (52.6%) had total hip replacement surgery. The majority (80.8%) of the individuals fell between the ages of 50 and 79 with

10.4% of individuals falling into the 80 or older category and only 8.9% were less than 50 years of age. The mean age was found to be 65.64 years (SD=11.61), with the youngest patient at age 24 and the oldest at 92 (Table 5). The number of procedures varied each year from 258 to 355 with the highest number of procedures done in 2003.

Table 4: Characteristics of total study population, eastern region of Newfoundland and Labrador, 2002-2005

Characteristic	N	%
Sex		
Male	506	41.9
Female	703	58.1
Replacement Type		
Total Hip	640	52.6
Total Knee	576	47.4
Age		
<50 Years	107	8.9
50-64 Years	424	35.1
65-79 Years	552	45.7
≥80 years	126	10.4
Year of Procedure		
2002	258	21.1
2003	355	29.2
2004	290	23.8
2005	313	25.7

4.2.1 Description of Wait Times

Tables 5 and 6 describes the wait times of the study population. When looking at the first stage of the wait (the time between the last visit to GP with an arthritis diagnosis code until the first orthopedic surgeon visit), it was found that slightly more than half (50.5%) saw the orthopedic surgeon (OS) within three months, and almost one third of patients

(32.4%) waited more than six months. The mean wait time for this first stage of the wait was 10.21 months (SD=17.81) with the time ranging from as short as 0.04 months (one day) to 112.39 months.

Table 5: Mean age and wait times for study population, eastern region of Newfoundland and Labrador, 2002-2005

Characteristic	Mean	SD	Range	Median
Age (n=1,209)	65.64	11.61	24-92	66.00
Wait Time (months)				
GP[1] to OS[2] (n=713)	10.21	17.81	0.04-112.4	2.93
OS[2] to Wait List (WL)[3] (n=214)	45.96	41.85	0-136.80	33.61
WL[3] to Procedure (n=213)	3.54	2.93	0.07-15.50	2.79
OS[2] to Procedure (n=706)	42.51	37.29	0.04-139.40	31.16
GP[1] to Procedure (n=713)	52.31	38.09	0.46-140.40	47.14

[1]Last GP (General Practitioner) visit with an arthritis diagnosis code before first Orthopedic Surgeon (OS) visit
[2]First Orthopedic Surgeon (OS) visit
[3]Date placed on Wait List (WL)

For the second stage of the wait, the time between the first specialist visit and the procedure, 38.2% of patients had their procedure within 18 months and more than a quarter (26.6%) of patients waited more than 72 months. The mean wait time for this second part of the wait was 42.51 months (SD=37.29) with the shortest time waited being 0.04 months (one day) and the longest wait was 139.43 months.

Table 6: Wait times of total study population, eastern region of Newfoundland and Labrador, 2002-2005

Wait Time Measure	N	%
GP[1] to OS[2] (n=713)		
<3 Months	360	50.5
3-6 Months	122	17.1
>6 Months	231	32.4
OS[2] to WL (n=214)		
<18 Months	79	36.9
18-48 Months	44	20.6
48-72 Months	26	12.1
>72 Months	65	30.4
WL to Procedure (n=213)		
<3 Months	112	52.6
3-6 Months	62	29.1
>6 Months	39	18.3
OS[2] to Procedure (n=706)		
<18 Months	270	38.2
18-48 Months	156	22.1
48-72 Months	92	13.0
>72 Months	188	26.6
GP[1] to Procedure (n=713)		
<18 Months	187	26.2
18-48 Months	173	24.3
48-72 Months	110	15.4
>72 Months	243	34.1

Looking at the combined total wait time, from GP visit to procedure, it was found that just over a quarter of patients (26.2%) waited a total of less than 18 months and almost half (49.5%) waited more than 48 months. The mean wait time was 52.31 months (SD=38.09) with the time ranging from 0.46 months to 140.39 months. As can be observed from Figure 2, the longest piece of the total wait time is from first orthopedic surgeon visit until placement on the wait list.

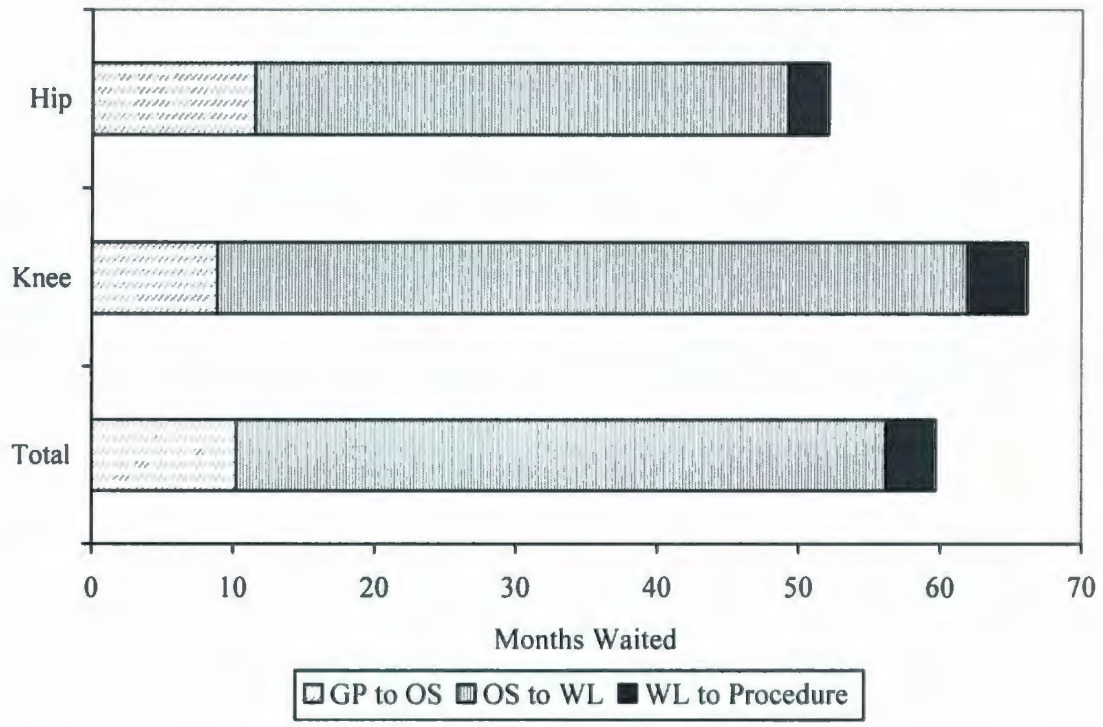

Figure 2: Total months waited by wait time measure

The wait time can be further broken down for those patients for whom WL data is available. For the time between first seeing the orthopedic surgeon until placement on the wait list, more than a third (36.9%) waited less than 18 months, and almost a third (30.2%) waited more than 72 months. The mean amount of time waited from the first orthopedic surgeon visit until placement on the wait list was found to be 45.96 months (SD=41.85) with some patients being placed on the wait list on the same day as the first visit and others waiting up to 136.75 months. For the time on the official wait list, it was found that a little more than half of patients (52.6%) waited only three months for the

procedure after being placed on the wait list, while 18.3% were found to have waited more than six months. The mean wait time for this step of the wait was found to be 3.54 months (SD=2.93) with the time ranging from 0.07 (two days) to 15.50 months. Figure 3 shows the comparison in the wait time on the wait list to the total wait time from referral to TJR surgery identified in this study.

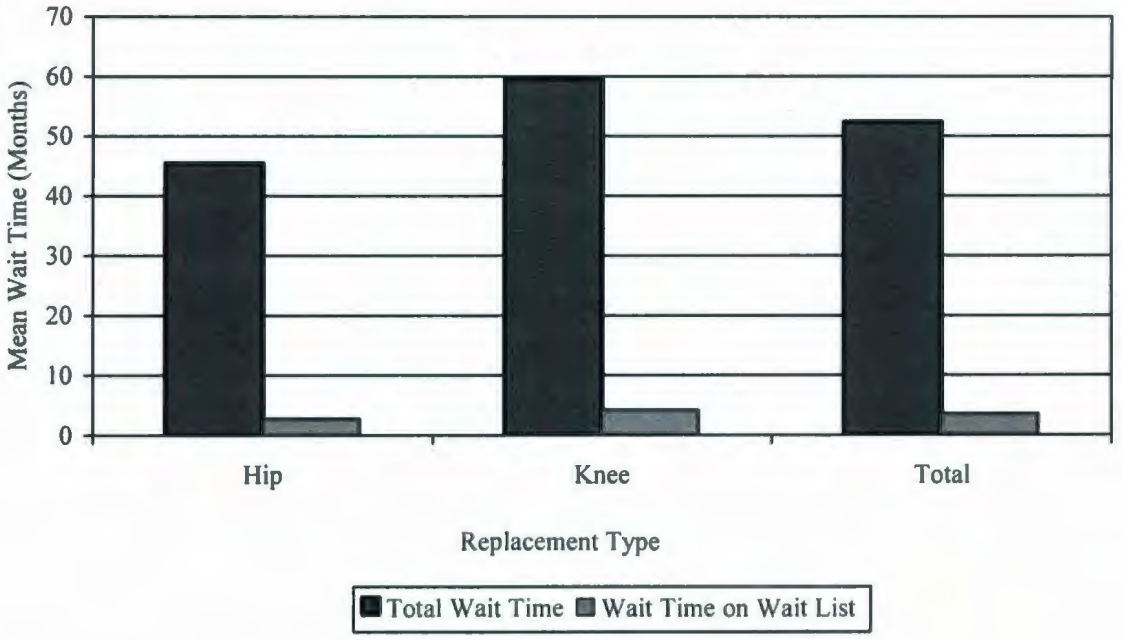

Figure 3: Total wait time compared to wait list wait time

4.2.2 Description of Health Service Utilization

Tables 7 and 8 describes the health service utilization of patients by looking at the number of hospital separations and number of fee-for-service physician visits during the five years before the wait time started and the five years after the wait time started. Also,

the number of comorbidities is described as well as the length of hospital stay after the joint replacement.

More than three in five patients (63.3%) had no hospital separations in the five years prior to the wait time start and more than half (52.7%) had fewer than 25 visits to a fee-for-service physician during the same time period. The mean number of hospital separations before the wait time start was less than one (0.92, SD=1.94) with the number ranging from zero to 22 separations during this time period. The mean number of fee-for-service physician visits during this same time period was 33.57 (SD=39.86) with the number of visits ranging from zero to 415. For the five years after the wait time began, more than two in five (42.3%) of patients had three or more hospital separations, and more than half (54.2%) had 50 or more visits to a fee-for-service physician. The mean number of hospital separations for this time period was 2.80 (SD=2.62) with a range of zero to 21, and the mean number of physician visits was 66.04 (SD=50.80) with the number of visits ranging from zero to 653 visits.

When the length of stay in hospital for the joint replacement procedure was described, it was found that almost half (48.8%) of patients had a length of stay after the TJR procedure of less than one week. More than one in five (22.0%) patients had a length of stay of more than ten days. The average length of stay was found to be 9.83 days (SD=9.95) with patients staying as few as two days and as long as 157 days.

Table 7: Health care utilization of total study population, eastern region of Newfoundland and Labrador, 2002-2005

Characteristic	N	%
Number of Hospitalizations* 5 years pre begin WT		
0	761	63.3
1-2	304	25.3
3 or more	152	11.4
Number of Hospitalizations* 5 years after begin WT		
0	134	11.1
1-2	559	46.5
3 or more	509	42.3
Number of MCP Visits 5 years pre begin WT		
<25	634	52.7
25-49	301	25.0
50-100	204	17.0
>100	63	5.2
Number of MCP Visits 5 years after begin WT		
<25	162	13.5
25-49	377	31.4
50-100	472	39.3
>100	191	15.9
Length of Stay		
1-6 days	587	48.8
7-10 days	351	29.2
>10 days	264	22.0
# pre-existing comorbidities		
0	306	25.6
1	284	23.8
2	257	21.5
>2	346	29.0
# newly diagnosed comorbidities		
0	250	20.8
1	326	27.1
2	279	23.2
>2	338	28.1

*Hospital separations for the TJR procedure were not included as a hospitalization.

Table 8: Mean and median health care utilization

Characteristic	Mean	SD	Range	Median
Number of Hospitalizations (n=1,202)				
5 Years before WL start	0.92	1.94	0-22	0.00
5 Years after WL start	2.80	2.62	0-21	2.00
Number of MCP Visits (n=1,202)				
5 Years before WL start	33.57	39.86	0-415	23.00
5 Years after WL start	66.04	50.80	0-653	54.00
Length of Stay (days) (n=1,202)	9.83	9.95	2-157	8.00
Number of Diagnosed Comorbidities (n=1,193)				
Pre-existing Diagnoses	1.80	1.63	0-8	2.00
New Diagnoses	1.92	1.71	0-10	2.00

The most common comorbidity (condition that patients had in addition to arthritis) among the study population was hypertension with 77.8% of patients being diagnosed with this condition. This did not include only newly diagnosed conditions, instead, it captured any condition that showed up as a diagnosis in the CDMS or MCP databases from January 1, 1995 to March 31, 2006. Almost two in five (39.0%) had at least one diagnosis of depression. More than one in three (35.2%) had ischemic heart disease and more than a quarter (26.9) had diabetes. Almost a quarter of patients (23.6%) had COPD and just over one in five (22.2%) had peripheral vascular disease. Less common comorbidities were chronic renal failure (3.1%) and cerebrovascular disease (3.5%) (Table 9, Figure 4).

The average number of comorbidities that patients had prior to the wait time start was 1.80 (SD=1.64) with some patients having no pre-existing conditions and others having up to eight. The mean number of newly diagnosed conditions was almost two (1.92,

SD=1.71) with some patients having no new diagnoses and others having up to ten (Table 8).

Table 9: Frequency of diagnosed comorbidities among the study population

Condition	n	%
Arthritis	1,214	100
Asthma	191	15.7
Cerebrovascular Disease	43	3.5
Chronic Obstructive Pulmonary Disease (COPD)	286	23.6
Chronic Renal Failure	38	3.1
Depression	474	39.0
Diabetes	327	26.9
Heart Failure	113	9.3
Hypertension	944	77.8
Ischaemic Heart Disease (IHD)	427	35.2
Peripheral Vascular Disease	269	22.2
Phlebitis/Thrombophlebitis	109	9.0
Stomach/Intestinal Ulcers	139	11.4

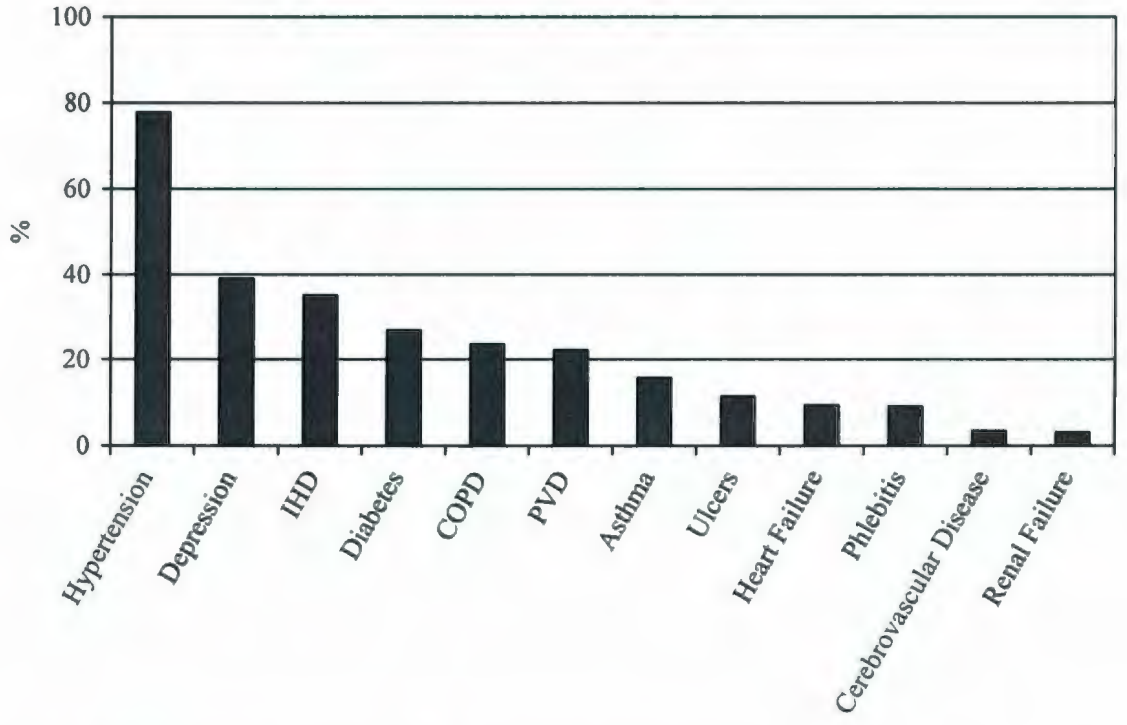

Figure 4: Percentage of patients with diagnosed comorbidities

4.3 Differences among Wait Time Groups

As described previously, wait time was grouped into short wait times (less than 18 months, n=187), moderate wait times (between 18 and 48 months, n=173), long wait times (between 48 and 72 months, n=110) and very long wait times (greater than 72 months, n=243) for analytical purposes. Comparison were made between demographics and wait time groups to determine whether the time patients waited were associated with age, gender, type of replacement or year of replacement. Analyses were also performed to determine whether wait time was associated with a difference in health service utilization as measured by number of hospital separations, number of fee-for-service physician visits, and length of hospital stay for TJR, or with number of previous or new comorbidities.

4.3.1 Demographics and Wait Times

When comparisons were done between the patients who received hip replacements to those who received knee replacements, it was found that the wait time was significantly longer for knee replacement patients for all measures after the first specialist visits ($p<0.01$). However, a significant difference was found for the time period between last GP visit with an arthritis diagnosis to first specialist visit, with hip replacements waiting slightly longer ($p=0.046$) (Table 10).

Table 10: Differences in mean wait time by replacement type

Characteristic	Mean (SD)		t	p-value
	Hip	Knee		
Age (n=1,209)	65.09 (13.04)	66.25 (9.74)	-1.77	0.08
Wait Time (months)				
GP[1] to OS[2] (n=713)	11.50 (19.67)	8.85 (15.53)	2.00	0.046
OS[2] to WL (n=214)	37.38 (41.49)	53.14 (41.00)	-2.72	<0.01
Wait List (WL) (n=213)	2.81 (2.44)	4.18 (3.17)	-3.57	<0.01
OS[2] to Procedure (n=706)	34.29 (35.65)	51.12 (37.08)	-6.15	<0.01
GP[1] to Procedure (n=713)	45.41 (37.52)	59.54 (37.38)	-5.03	<0.01

No significant differences were found among wait times for females when compared to males (Table 11). Using a one-way ANOVA for age groups of less than 50 years, 50 to 64, 65 to 79, and 80 and above, no significant differences were found with respect to wait times. However, t-tests comparing patient in the less than 65 age group to those 65 and older found a significant difference with wait times from first OS visit to procedure and for the total wait time of last GP visit to procedure. It was found that the younger patients waited significantly longer than those patients aged 65 and older for the wait time from OS visit to procedure (p=0.021) and as well for the total wait time (p=0.027) (Table 12).

Table 11: Differences in mean wait time by sex

Characteristic	Mean (SD)		t	p-value
	Male	Female		
Age (n=1,209)	64.00 (11.02)	66.83 (11.88)	-4.21	<0.01
Wait Time (months)				
GP[1] to OS[2] (n=713)	10.34 (18.09)	10.12 (17.62)	0.17	0.87
OS[2] to WL (n=214)	42.24 (42.29)	48.51 (41.51)	-1.08	0.28
Wait List (WL) (n=213)	3.65 (2.87)	3.47 (2.98)	0.46	0.65
OS[2] to Procedure (n=706)	41.20 (37.12)	43.45 (37.44)	-0.79	0.43
GP[1] to Procedure (n=713)	51.13 (37.95)	53.15 (38.21)	-0.70	0.49

Table 12: Difference in mean wait time by age group

Characteristic	Mean (SD)		t	p-value
	<65 Years	65+ Years		
Wait Time (months)				
GP[1] to OS[2] (n=713)	10.14 (19.29)	10.26 (16.71)	-0.09	0.93
OS[2] to WL (n=214)	48.91 (43.44)	43.78 (40.67)	0.89	0.38
Wait List (WL) (n=213)	3.51 (2.59)	3.56 (3.17)	-0.12	0.90
OS[2] to Procedure (n=706)	46.39 (38.12)	39.79 (36.51)	2.32	0.02
GP[1] to Procedure (n=713)	56.06 (38.31)	49.67 (37.75)	2.21	0.03

4.3.2 Wait Time and Health Service Utilization

Comparisons were done to see if any differences existed in the number of MCP and hospital separations in the five years before the wait time started versus the five years after the wait time started for each wait time group. Table 13 shows that the mean number of hospital separations was significantly higher in the five years after the start of the wait time than the five years before the wait time began for all wait time groups ($p<0.01$). Significant differences were also found with the number of MCP visits after the wait time began being significantly higher than those MCP visits before the wait time began ($p<0.01$) for all groups except the short wait time group ($p=0.25$) (Table 14).

Table 13: Number of hospital separations by wait time

Characteristic	Mean # Hospitalizations (SD)		t	p-value
	5 Years Before	5 Years After		
Wait Time				
Short	1.59 (2.32)	2.61 (2.02)	-5.20	<0.01
Moderate	1.51 (2.79)	3.29 (2.42)	-8.00	<0.01
Long	0.88 (1.38)	3.21 (2.27)	-9.83	<0.01
Very Long	0.43 (1.13)	2.51 (2.56)	-12.02	<0.01

Table 14: Number of physician visits by wait time

Characteristic	Mean # MCP Visits (SD)		t	p-value
	5 Years Before	5 Years After		
Wait Time				
Short	55.86 (42.72)	51.52 (54.98)	1.16	0.25
Moderate	56.98 (47.59)	69.42 (38.48)	-4.42	<0.01
Long	43.32 (39.65)	76.15 (43.83)	-11.53	<0.01
Very Long	20.91 (26.38)	78.42 (53.62)	-17.69	<0.01

A one-way ANOVA was performed, looking at differences within wait time groups by number of visits (Table 15). Significant differences were found when the number of MCP visits for each wait time group were compared ($p<0.01$). Post hoc tests found that those in the very long wait time group had significantly fewer MCP visits in the five years before the wait time began than those in the other wait time groups ($p<0.01$). Also, those in the long wait time group had fewer visits than those in the moderate wait time group ($p=0.047$). For the MCP visits in the five years after the wait time started, those in the short wait time group had significantly fewer visits than those in all other wait time groups ($p<0.01$) (Table 16).

Table 15: Summary of One-way ANOVA by wait time groups (short, medium, long and very long)

Characteristic	SS	df	Mean Square	F	p-value
# Hospitalizations 5 Years Before WL					
Between Groups	188.4	3	62.8	15.6	<0.01*
Within Groups	2,859.5	709	4.03		
Total	3,047.9	712			
# Hospitalizations 5 Years After WL					
Between Groups	85.5	3	28.5	5.2	<0.01*
Within Groups	3,910.9	709	5.5		
Total	3,996.5	712			
# MCP Visits 5 Years Before WL					
Between Groups	182,941.7	3	60,980.6	40.5	<0.01*
Within Groups	1,068,742.4	709	1,507.4		
Total	1,251,684.1	712			
# MCP Visits 5 Years After WL					
Between Groups	84,314.7	3	28,104.9	11.6	<0.01
Within Groups	1,722,076.4	709	2,428.9		
Total	1,806,391.1	712			

*Unequal variance found, however both Welch and Brown-Forsythe tests were significant at $p<0.01$ indicating that a significant difference was found.

The post hoc tests also showed significant differences in the number of hospital separations for the wait time groups. For the number of hospital separations during the five years prior to the wait time start, those in the very long wait time group had fewer hospital separations than those in all other wait time groups ($p<0.01$ for all except the moderate wait time, where $p=0.02$). Those in the long wait time group had fewer hospital separations than those in the short wait time group ($p<0.01$) and fewer than those in the moderate wait time group, although this difference was not statistically significant ($p=0.057$). For the five years after the wait time started, those in the moderate wait time

group had significantly fewer hospital separations than those in the short wait time group (p=0.02) and those in the very long wait time group (p=0.01).

Table 16: Post-Hoc tests for number of visits and wait times

	Mean (SD) # Visits			
	Hospitalizations		MCP Visits	
	Before WL	After WL	Before WL	After WL
Wait Time				
Short	1.59 (3.32)	2.61 (2.02)	55.86 (42.72)	51.52 (54.98)**
Moderate	1.51 (2.79)	3.29 (2.42)*	56.98 (47.59)	69.42 (38.48)
Long	0.88 (1.38)*	3.21 (2.27)	43.32 (39.65)*	76.15 (43.83)
Very Long	0.43 (1.13)**	2.51 (2.56)	20.91 (26.38)**	78.42 (53.62)

* Significant differences found with some other wait time groups

**Significant differences found with all other wait time groups.

A Chi-Square test was done to look at the number of comorbidities patients had by wait time group. It was found that the Chi-Square test was significant for both the comorbidities patients had before the wait time began (p<0.01) as well as the new diagnoses (p<0.01) (Table 17). However, because the time periods were limited to five years, drawing conclusions from this is difficult. For example, of those patients who had a short wait time, five (2.7%) had no comorbidities diagnosed during the time period before the referral date and 105 (56.1%) had three or more comorbidities diagnosed during this time. The percentage of cases in the very long wait time group that had no previous diagnoses (24.7%) was much higher than the percentage for the other three wait time groups (2.7%, 4.6% and 6.4% for short, moderate and long wait times, respectively). It is difficult to determine whether these results are due to limiting the time to five years,

because those with a short wait time had a longer period of time (before the wait time started) to accumulate comorbidities than those with a very long wait time. Because of this issue, the negative binomial regression was performed to control for the elapsing of time.

Table 17: Number of comorbidities by wait time

	Wait Time n (%)						
Comorbidities	**Short**	**Moderate**	**Long**	**Very Long**	χ^2	**df**	**p-value**
Previously Diagnosed							
0	5 (2.7)	8 (4.6)	7 (6.4)	60 (24.7)			
1	21 (11.2)	27 (15.6)	28 (25.5)	80 (32.9)	134.98	9	<0.01
2	56 (29.9)	47 (27.2)	33 (30.0)	56 (23.0)			
3+	105 (56.1)	91 (52.6)	42 (38.2)	47 (19.3)			
Newly Diagnosed							
0	102 (54.5)	73 (42.2)	20 (18.2)	29 (11.9)			
1	54 (28.9)	53 (30.6)	39 (35.5)	41 (16.9)	187.03	9	<0.01
2	23 (12.3)	31 (17.9)	29 (26.4)	77 (31.7)			
3+	8 (4.3)	16 (9.2)	22 (20.0)	96 (39.5)			

A one-way ANOVA was performed to compare patient's length of stay after the joint replacement by wait time groups. No significant differences were found when total wait time was considered (p=0.20) (Table 18). In order to get an idea of whether the official wait list wait time was associated with an increase or decrease in length of time after the procedure, it was thought that it would be beneficial to look at this segment of the true wait time. In addition, the wait time from the first orthopedic surgeon visit until patients were placed on the wait list was also analyzed for this purpose. It was found that patients who waited less than two years had a shorter length of stay when compared to those who

waited two years or more ($p<0.01$). Also, for the time on the wait list itself, those who waited less than three months were compared to those who waited three months or more and the opposite was found; those who waited the shorter amount of time had the longer length of stay ($p=0.03$) (Table 19).

Table 18: Length of stay by total wait time groups (short, medium, long and very long)

Characteristic	SS	df	Mean Square	F	p-value
Length of Stay (days)					
Between Groups	510.0	3	170.0	1.6*	0.2
Within Groups	76887.8	709	108.5		
Total	77397.8	712			

*Unequal variance found, also both Welch and Brown-Forsythe tests were not significant indicating that no significant difference was found.

Table 19: Length of stay by wait time groups (short versus long, for orthopedic surgeon until WL and time on WL).

Characteristic	Mean (SD)		t	p-value
	Short*	Long**		
Length of Stay (days)				
OS to WL	7.72 (3.28)	9.28 (5.15)	-2.70	<0.01
WL to Procedure	9.25 (5.27)	7.93 (3.35)	2.20	0.03

* Short wait time defined as less than two years for OS visit to WL; less than three months for WL to procedure.

** Long wait time defined as two years or more from OS to WL and three months or more on WL.

4.4 Predictors of Health Service Utilization

A multiple linear regression was performed to determine whether there were any predictors of length of stay in hospital after the TJR. A negative binomial regression was

performed to look at number of visits and number of comorbidities while the patients were waiting.

4.4.1 Length of Stay

Results of the multiple linear regression are presented in Table 20. The independent variables included age, sex, type of replacement, total wait time, number of physician visits and hospitalizations in the five years before the wait time started, number of physician visits and hospital separations in the five years after wait time began, number of pre-existing comorbidities and number of new comorbidities. The variables entered into the analysis accounted for 10.0% of the variation of length of stay after joint replacement ($F(12, 609) = 7.76$, $p<0.01$).

Table 20: Multiple linear regression for length of stay

				R^2=10.0
	Unstandardized coefficients		**Standardized Coefficent**	
Model (n=709)	**B**	**SE**	**β**	**p-value**
(constant)	1.456	0.110		<0.01
Age	0.006	0.002	0.142	<0.01
Female	0.059	0.034	0.640	0.085
Knee replacement	-0.003	0.033	-0.004	0.920
Wait Time	0.000	0.001	0.019	0.684
Hospitalizations-previous	0.002	0.010	0.010	0.822
Hospitalizations-during	0.023	0.008	0.120	0.004
Physician Visits-previous	0.001	0.001	0.082	0.173
Physician visits-during	0.000	0.000	0.032	0.519
Previous comorbidities	0.006	0.014	0.021	0.676
New comorbidities	0.044	0.014	0.151	0.001

Increasing age, a higher number of hospital separations during the wait time and new comorbidities diagnosed during the wait time were all found to be significantly associated with an increased length of stay ($p<0.01$). Type of replacement and wait time were not found to be associated with length of stay. Age and wait time were treated as continuous variables. Similar results were found when the total wait time was grouped into short, medium, long and very long categories and age was grouped into less than 65 years and 65 years and older categories. A survival analysis was also performed and results were consistent with those reported here.

4.4.2 Number of visits and comorbidities

Results of the negative binomial regression are presented in Table 21. Three regressions were performed to look at the number of hospital separations, number of physician visits and number of comorbidities as the outcomes, respectively. The independent variables were previous visits, age, sex, type of replacement, and wait time and the offset was the elapsed time while waiting.

For hospital separations, it was found that patients were more likely to have a higher number of hospital separations during the wait time if they had a higher number of hospital separations before the wait time began (Incidence Rate Ratio (IRR) 1.1, $p<0.01$), were older (IRR 1.01, $p<0.01$), or had a knee replacement (IRR 1.14, $p=0.014$). An association was also found with females having fewer hospital separations than males, but this was only marginally significant ($p=0.058$) and as such should be interpreted with

caution. Wait time was not found to be associated with number of hospital separations ($p=0.466$).

Similarly, it was found that patients were more likely to have a higher number of physician visits during the wait time if they had a higher number of physician visits before the wait time began (IRR 1.02, $p<0.01$), were older (IRR 1.003, $P<0.01$), or had a knee replacement (IRR 1.08, $p<0.01$). Wait time was not found to be associated with number of physician visits ($p=0.48$).

When the number of comorbidities diagnosed during the wait time was analyzed, it was found that patients were more likely to have a higher number of conditions diagnosed if they had fewer physician visits before the wait time began (IRR 0.85, $p<0.01$) or were older (IRR 1.01, $p<0.01$). No association was found with number of comorbidities and gender or type of replacement. However, wait time was found to be significant (IRR 1.001, $p=0.03$). Thus, for every 100 additional days of waiting for TJR surgery, patients have a 0.1% increase in risk of additional comorbidities.

Table 21: Negative binomial regression for health services use and comorbidities

Characteristic	IRR	95% CI	p-value
Number of Hospitalizations			
Previous hospitalizations	1.100	1.044, 1.159	<0.01
Age	1.009	1.004, 1.014	<0.01
Female	0.900	0.807, 1.004	0.06
Knee Replacement	1.144	1.028, 1.273	0.01
Wait Time	1.100	0.999, 1.000	0.47
Number of Physician Visits			
Previous physician visits	1.017	1.014, 1.020	<0.01
Age	1.003	1.001, 1.006	0.01
Female	1.049	0.993, 1.109	0.09
Knee Replacement	1.075	1.019, 1.134	0.01
Wait Time	1.000	0.999, 1.000	0.48
Number of Comorbidities			
Previous physician visits	0.854	0.779, 0.936	<0.01
Age	1.012	1.008, 1.015	<0.01
Female	0.940	0.864, 1.022	0.15
Knee Replacement	0.992	0.914, 1.078	0.86
Wait Time	1.001	1.000, 1.001	0.03

CHAPTER 5

DISCUSSION

5.1 Introduction

The aim of this study was to describe wait times experienced for total joint replacement in the Eastern Region of Newfoundland and Labrador from 2002 to 2005 and determine whether patients experiencing longer waits differ from those who have shorter total wait times in terms of health service utilization. The use of administrative data enabled the possibility of measuring wait times experienced before placement on the official wait list, but because of limitations with the administrative data (for example, not capturing the referral date), the most accurate total wait time could not be measured. The final analysis file measured the time waited from the last visit to the GP before the first orthopedic surgeon visit and therefore provides some idea of the total wait time patients experienced. However, it is expected that this is an underestimation of the total wait experienced by patients. Also, the administrative data allowed for the tracking of patients through the health care system while they waited, therefore the number of visits to physicians and hospitalizations as well as the diagnosis codes for those visits could be obtained.

5.2 Study Population

Just over half of patients who underwent TJR surgery in the Eastern region of Newfoundland and Labrador from 2002-2005 were females. Arthritis has been shown to affect more females than males (Gabriel and Michaud, 2009; Hawker et al., 2009), therefore it would be expected that more females would require TJR surgery. This is

consistent with other studies looking at the demographics of patients receiving TJR surgery (Memtsoudis et al, 2008; Roder et al., 2003; Soohoo, Liberman, Ko and Zingmond, 2006).

There were slightly more hip replacements than knee replacements done in eastern NL during the study period. CIHI reports on joint replacements for all of Canada, including provincial breakdowns, since the 2002 report. For the first two reporting years (fiscal years 1994/95 and 1995/96), slightly more hip replacements than knee replacements were completed in Canada. From 1996/97 onward, there have been more knee replacements than hip replacements with a continuously widening gap for each year. For Newfoundland and Labrador, hip replacements were more common than knee replacements in fiscal years 2000/01 and 2002/03. But in fiscal year 2001/02 and since 2004/05, the number of knee replacements has been much higher than the number of hip replacements in Newfoundland and Labrador (CIHI, 2002-2008).

Differences in the numbers of procedures performed between the CIHI reports and this study are expected because CIHI reports on data for the entire province, as reported by orthopedic surgeons participating in the Canadian Joint Replacement Registry (CJRR) whereas this study reported on procedures performed in the Eastern Regional Health Authority. Therefore, comparisons between the numbers in this study and the provincial numbers of the CIHI reports cannot be made.

This trend of increasingly more knee replacements than hip replacements has been discussed in the literature as well (Dixon, Shaw, Ebrahim and Dieppe, 2004; Wells et al., 2002). However, it is unknown whether the higher number of knee replacements compared to hip replacements is due to change in clinical practice, an increase in incidence of knee arthritis, or a change in patients' attitudes towards the surgery. Although what was found in this study does not show an increase in knee replacements compared to hip replacements during the study period, it would be interesting to investigate whether this would be found if additional years of data, or additional health authorities, were included. There are reports that indicate that this would be the case (CIHI, 2006; Department of Health and Community Services, 2009).

The age distribution of the patients was consistent with that in other studies (Kelly, Voaklander, Johnston and Suarez-Almazor, 2002). Most were between the ages of 50 and 79, with a mean age of 65.64 years. Females were found to be older than the male patients. The majority of TJR surgeries were performed on patients who were between the ages of 50 and 79. No significant difference were found with respect to the type of replacement and age, however, CIHI has reported that for Canada, knee replacement patients are older than hip replacement patients (CIHI, 2002-2008).

5.3 Measuring Wait Times

Patients in this study were retrospectively followed from prior to the first specialist visit until the joint replacement occurred. Many waits occur during those times, from referral

by the family physician until the specialist appointment, placement on the surgical wait list and finally the replacement. Ideally, capturing all those points in time would provide a detailed picture of what the patient experienced before a joint replacement procedure. However, for the purposes of this study, the last GP visit before the first orthopedic surgeon visit had to be taken as a proxy "referral visit" as the database did not include the referral date.

5.3.1 Wait Times for Wait List Data

Data for the surgical wait list was not available for all patients because the surgery department did not collect this information until February 2003. Therefore, from February 2003 until November 2005, the date that patients were placed on the wait list is available. The Government of NL reports on the wait times for the province for various procedures. Every quarter, the percentage of people who receive their surgery within the pan-Canadian benchmarks are released via the Department of Health website (Department of Health and Community Services, 2005-2009). These benchmarks were set out by the provincial and territorial governments in December 2005 in keeping with the commitment set out after the First Minister's Health Accord when the issue of wait times among the five priority areas was discussed (Norris, 2009).

The time between the first specialist visit and placement on the wait list had a large range with some patients being placed on the wait list on the same day as the first visit while others waited up to 136 months. It is expected that some of the wait time in this segment

can be attributed to the need for further diagnostic testing, such as x-rays, CT scans, or MRI. The wait time for diagnostic imaging in NL has been fairly long during those years as well. The Fraser Institute reports on hospital wait times annually. Over the last ten years in NL, wait times for CT scans have ranged from four to eight weeks, with the shortest time reported in 2003 and the longest in 2001/02. Wait times for MRIs during this time period in NL have ranged from 17 weeks in 1999 to 36.5 weeks in 2005 (Esmail and Walker, 2002-2006).

Few studies have measured the time from first specialist visit until placement on the wait list. One study that did, found that among five hospitals in Quebec, the median wait time from first specialist visit to the date of being placed on the wait list was zero months (Gaudet et al., 2007). The authors suggest that this may be because patients are being referred only after surgery is necessary (in other words, when the condition is severe). However, without knowing how long patients are waiting to see the specialist, a big piece of the wait is missing. For example, if patients are getting referred when the condition is severe and have a long wait to see the specialist than this wait time is quite important to the patient.

The wait time from first specialist visit to getting placed on the wait list reported here was much longer than that reported by Gaudet et al. (2007). It may be that patients in NL are being referred when they are at a much earlier place in the course of the disease and therefore are not ready for surgery at the time of first visit. Also, if orthopedic surgeons

are ordering diagnostic imaging for their patients before the decision is made regarding surgery, then this may be the cause of some of this wait time.

For the wait list segment, the wait times have been found to be relatively short, with about half of patients receiving the surgery within three months. Most studies that report on wait times for TJR surgery are reporting on this segment of the wait. Results from two studies in Canada reported wait times (for the wait list segment) that were similar to the ones found in this study (Kelly et al., 2002; Quan, Lafreniere and Johnson, 2002).

It has been suggested that wait lists can be manipulated placing patients on the wait list only when surgery can be provided within certain time frames (Dobson, 2002; Ferriman, 2002). Therefore, by placing people on the wait list when surgery can be done within this time period shows that people are experiencing reasonable wait times. However, as it has been shown, patients are waiting a considerable amount of time before being placed on the wait list. It would be incorrect to assume that as soon as a person with an arthritis diagnosis is referred to an orthopedic surgeon that they should receive a joint replacement within the defined benchmark of 182 days. Patients, themselves, may not be ready due to personal reasons and/or the disease may not, at that point, be severe enough to warrant surgery. However, because of the long time patients wait to see the surgeon, years may pass after the referral date before the surgery takes place. That gives more years for the disease to progress, further limiting the functional ability of the patients.

5.3.2 Total Wait Times

Patients begin waiting immediately after the family physician refers them to an orthopedic surgeon. The time spent in this segment of the wait was not able to be accurately measured because the date of referral was not available in the databases. Therefore, taking the last GP visit (with an arthritis diagnosis code) before the first specialist visit was the most appropriate way to capture a part of this segment. It is expected that this is an underestimation of the actual time spent waiting to see the specialist because patients will generally continue to see their family physician for their arthritis-related health issues while they are waiting to see the orthopedic surgeon. Approximately half of patients in this study saw the orthopedic surgeon in less than three months after the last GP visit resulting in the arthritis diagnosis code.

Results from this study show that patients in NL experience a considerable amount of time waiting to see an orthopedic surgeon. Because the wait time measured here is expected to be an underestimation, this wait time period may be a significant burden for the patients. Reports have shown that patients typically endure prolonged waits to see many specialists. In Canada, wait times to see orthopedic surgeons have generally been the longest across all specialties reported by the Fraser Institute. For all specialists combined, Newfoundland and Labrador has been shown to have the longest wait time from GP to specialist. Numbers reported by the Fraser Institute show patients, across Canada, waiting almost 17 weeks to see an orthopedic surgeon (Esmail and Walker 2006). Therefore, the waiting patients in eastern Newfoundland experienced for this

segment of the total wait time was greater than that in the rest of Canada. However, the Fraser Institute reports on wait times based on surgeons' responses to surveys, and therefore, may not be a true representation of the actual wait times experienced in each province.

Only one study was found that measured the time that patients waited from referral date to first specialist visit. This study, done in Ontario, found patients to wait an average of 3.2 months, however some patients experienced wait times for this segment of 10 months or more (Mahon et al., 2002). The present study found a median wait time of 2.93 months from the proxy referral date until the first specialist visit. However, the range of wait times showed that some patients waited more than 100 months. Because a proxy wait time was used, it is unable to be determined whether that was the actual referral wait time.

The second segment of the total wait time was from first OS visit to procedure. Patients in this study were shown to experience a mean wait time of approximately three and a half years with more than a quarter of patients waiting more than six years after the first specialist visit until the TJR surgery. This wait time segment includes the time spent waiting on the wait list, but this date was not available for all patients. In addition, this includes the time spent waiting for any diagnostic tests that the orthopedic surgeon may order. As not all patients who are referred to an orthopedic surgeon need a joint replacement, the validity of using this segment of the wait time may be questioned.

However, because this is a retrospective study, it is known that these patients have undergone TJR. Therefore, the goal was to determine, with the use of administrative databases, what happened to these patients while they were waiting.

The Fraser Institute has reported wait times for first orthopedic surgeon visit to procedure, for Newfoundland and Labrador, to be approximately twelve weeks (ranging from 11.8 weeks in 2003, 12.8 in 2006, 12.4 in 2007 and 18.8 in 2008) (Esmail and Walker, 2004-2005; Esmail, Walker and Wrona, 2006; Esmail, Walker and Bank, 2007; Esmail et al., 2008). Because the government of NL reports on the percentage of patients who receive their surgery within the benchmarks and does not report the mean and/or median wait times, it is difficult to compare results from this or other studies to the provincially reported numbers. Over the last few years, this percentage of patients who receive their surgery within the benchmarks has been decreasing. The numbers of people on the wait lists for TJR surgery during this time has increased (Department of Health and Community Services, 2008) which is a likely explanation for the lower number of cases performed within the benchmarks. This is especially true for knee replacement surgeries, and because of this, Eastern Health has formed a committee whose goal is to review what is occurring across Canada with regard to improving access to surgery (Department of Health and Community Services, 2009).

Combining the two segments (from referral to first specialist visit and from first specialist visit to TJR surgery) gives a total wait time from GP referral to procedure. Even though

the date of referral is not available, using the date that was chosen shows that patients are experiencing prolonged waits for TJR surgery. Results from studies that measured this total wait time have reported wait times to be much lower than those found here. Mahon et al. (2002) reported a mean total wait time of approximately six months. The median total wait time found in the present study is much longer than that reported by Mahon et al. (2002) and the reason for this difference appears to be due to the time between first specialist visit and getting placed on the wait list. This wait time is most difficult to adjust for because so many factors come into play for this segment. Reasons for a prolonged time between first visit and placement on the wait list could be that some patients are not ready for surgery when they are referred due to their personal choice or because the disease has not progressed to the point where surgery is indicated, or due to time spent waiting for diagnostic imaging. Also what can affect this wait time is the patients' health status before surgery. For example, if a patient has been diagnosed with a chronic condition that needs to be controlled before surgery, then this will cause a delay in getting placed on the wait list.

5.3.3 Wait Times and Demographics

Total wait times were found to be significantly longer for knee replacement patients. This is consistent with the numbers reported by the provincial government (Department of Health and Community Services, 2008) and federally (CIHI, 2008). As reported by the Government of NL, the numbers of patients waiting for total knee replacement has been increasing over the last few years and this is likely the cause of the longer wait times for

knee replacement than that for hip replacement. Interestingly, the wait time from last GP visit to first OS visit was shorter for knee replacement patients compared to patients who received a hip replacement. Therefore, it seems as though patients with knee arthritis are getting seen by the specialist in a shorter amount of time, but are then having to wait even longer for the replacement. However, this cannot be confirmed because the actual referral date is not available.

No significant differences were found for wait times by sex. This is consistent with findings from other studies. A prospective study looking at change in pain and function among people waiting for TJR found no difference in the length of wait for men or women (Kelly et al., 2001). Similar findings were also reported in other studies (Gaudet et al., 2007; Kelly et al., 2002). CIHI reported on wait times for joint replacements only since the 2007 report (which analyzes data from the 2005/06 fiscal year). In that report, it was stated that across Canada, there was a significant difference in wait times by sex, with males having a longer wait time for hip replacement procedures than females. No such differences were found for knee replacements (CIHI, 2007). The most recent report also states that differences exist in wait times among males and females, with males waiting longer for hip replacements but shorter for knee replacements, however, it was not reported whether this difference was significant (CIHI, 2008).

In addition, no differences were found with respect to the total wait time by age groups when 15 year age groupings were used. Similar age groups were used previously (Kelly

et al., 2002) and findings are consistent with this study and others (Gaudet et al., 2007; Kelly et al., 2001). CIHI however, has reported that differences in wait times among age groups have existed. It has been reported that for the 2005/06 fiscal year, for hip replacement procedures, those aged 75 years and older had shorter wait times than those in the other age groups. No differences were found among knee replacement patients (CIHI, 2007). The most recent CIHI data includes data from fiscal year 2006/07 and shows that as age increases, wait times were found to decrease for hip replacement patients, but it was not stated whether the differences were significant. Again, no differences were found among knee replacement patients (CIHI, 2008). In this study, when age was grouped into those less than 65 years and those 65 and older, it was found that those in the older age group had a shorter wait time than those less than 65.

5.4 Effect of Waiting

Typically, interviews are used to look at the effect of waiting for surgery by measuring HRQoL. As discussed in Chapter 2, findings are mixed with some studies finding long wait times to be associated with worsening HRQoL, and others finding no negative impact. This study looks at whether wait times were associated with characteristics that could be measured with the use of administrative data. Variables such as length of stay, number of physician visits and hospital separations were measured. Also, the number of comorbidities that patients had before the start of the wait time, and those that developed during the wait time were analyzed.

5.4.1 Length of Stay

There was a large variation in length of stay. While most had a length of stay of less than one week, the mean was close to ten days. For several patients, the length of stay was found to be 100 days or more. For these patients it was quite possible that they were being kept in hospital until they could be moved to another health care facility (for example, a long term care facility). Because some patients in this study were above the age of 85, it is reasonable to assume that this is one possible explanation of those cases with lengths of stay greater than three months.

No differences were found when length of stay was looked at by wait times when the total wait time was used. However, when the wait time was broken down into the separate segments, it was found that those who waited two years or more from first visit to the orthopedic surgeon until they were placed on the wait list, had a longer length of stay than those with a wait time of less than two years. For the time from placement on the wait list until surgery, the opposite was found; those with the longer wait time (three months or more) had a shorter length of stay than those who waited less than three months.

A longer wait time before getting placed on the wait list may be caused by patients being too sick for surgery. This could then explain the longer length of stay for those patients who have the longer wait time before the wait list. However, it may also be that those who have a longer wait time spend more time in a functionally disabled state, allowing

for more time in which chronic conditions can develop (or be exacerbated). As a result of this, patients then may be in a worse condition when they have their surgery which would cause a longer length of time in hospital after the surgery. A longer length of stay associated with a shorter time on the surgical wait list may be a result of those who are in the worst condition getting their surgery faster. This would give evidence to stay that some prioritization of patients on the wait list may be occurring.

A multiple regression analysis showed that only 10% of the variation in length of stay could be explained by the variables in the study. This suggests that other factors are most likely impacting length of stay in hospital after TJR. Of the variables that were entered into the regression, age, the number of hospital separations during the wait time and the number of new comorbidities diagnosed during the wait time were all found to be positively associated with increased length of stay. The number of new comorbidities and number of hospital separations are likely to be associated with one another as the newly diagnosed comorbidities may be the reasons for the hospital separations; however this association was not examined. Increasing age, as well, is indicative of a longer length of stay because older people are more likely to have more comorbidity and also, older patients are more likely to require admission to another health care facility after the TJR. Total wait time was not found to be significantly associated with length of stay in the regression analysis.

A study by Hayes et al. (2000) found that age, sex and comorbidities were predictors of length of stay. This is consistent with the results given in this study, (with the exception of sex). Findings such as this show that patients who are sicker (which can be measured by those with a higher number of comorbidities) are more likely to have a longer length of stay. This association between increasing length of stay and a higher number of comorbidities was also found by Kreder et al. (2003) and Wang et al. (1998).

Mean length of stay reported by the above studies (Hayes et al., 2000; Wang et al., 1998) are comparable with that found here. CIHI reports from the years that cover the time frame for this study found Newfoundland and Labrador to have a mean length of stay after TJR surgery that was longer than the national average. In fiscal years 2003/04 and 2004/05 for Canada, mean length of stay after TJR surgery was nine days for hip replacement and seven days for knee replacement. In Newfoundland and Labrador, mean length of stay in fiscal year 2003/04 was 12.8 days for hip replacement and 10.9 days for knee replacement and in 2004/05 mean length of stay was 12 days for hip replacement and eight days for knee replacement. Hip replacement patients were found to have a longer length of stay than knee replacements, and the length of stay for females was longer than that for males (CIHI, 2005; CIHI, 2006). The most recent CIHI report (CIHI, 2008) shows no difference in length of stay by type of replacement or sex, which is consistent with the results found here, but still report a mean national length of stay, of seven days for hip replacement and six days for knee replacement, which is less than that

for NL, which was reported as nine days and seven days for hip and knee replacements, respectively.

The present results demonstrate that those with a longer length of stay in hospital, after a total joint replacement surgery, are more likely to have new comorbidities diagnosed during their wait for surgery. Even though wait time was not found to be associated with an increase in length of stay, a longer wait means an increasing amount of time in which new comorbidities can develop.

5.4.2 Health Service Utilization

The number of hospital separations and physician visits were analyzed both before the wait time started and during the wait time. It was found that patients had more visits during the wait time when compared to the same amount of time before the wait time started. Patients were broken into groups depending on the length of the total wait time. Comparisons were made by wait time group to determine whether those waiting a longer time before their surgery had similar health service utilization (as measured by hospital separations and physician visits) after the wait time started compared to the five year period before the wait time began. Only those waiting the shortest amount of time did not differ in the number of physician visits before the wait time started when compared to those during the wait time. This may be explained because of limiting the time to five year periods; therefore those with the shortest wait times had less time to accumulate physician visits and hospital separations after the wait time started than those in other

wait time groups. This effect of time however, was controlled with the use of the negative binomial regression analysis.

The negative binomial regression analysis, which controlled for time, found that those who were older, those who had a knee replacement and those with a higher number of previous hospitalizations or physician visits were more likely to have a higher number of visits during the wait time. Rate ratios were found to be significant with a small increase in risk of comorbidity with every 100 additional days of waiting. Previous work in this area has not compared health services use before the wait time started to that during the wait time. However, studies have been done to measure health service use for people with arthritis. Dominick, Ahern, Gold and Heller (2004), using administrative data, looked at physician visits related to arthritis only and found that patients who were shown to have higher levels of pain (as measured by a HRQoL instrument) were more likely to have an increased likelihood of higher numbers of physician visits. In a one-year period, 60% of patients had at least one physician visit with an arthritis diagnosis code. However, by limiting the analysis to include only visits with a general arthritis code (ICD 9 code 719), this may underestimate the visits that were coded as a more specific arthritis complaint. Also, any visits due to comorbidities were not included. The present study, which also looked at the numbers of physician visits, included visits for other diagnostic codes and captured a broader picture of physician visits while patients are waiting for TJR surgery.

Similarly, a study by Rosemann et al. (2007a) measured health service utilization by questionnaire and found that patients with arthritis were reporting an average of just over five physician visits and close to two orthopedic surgeon visits during a six month period. It was found that cases who reported higher levels of pain were more likely to also have higher number of visits. It is possible that for the present study, as shown by Dominick et al. (2004) and Rosemann et al. (2007a), patients with higher levels of pain had higher numbers of physician visits and hospital separations. However, without any HRQoL measures, it was unable to be determined whether this is the case. It would be interesting to investigate whether those with higher numbers of physician visits (and hospital separations) were more in need of TJR surgery, and if so whether a longer wait time for those with higher numbers of visits was due to comorbidities (preventing them from being suitable for surgery at that time), or whether they should have been given priority and therefore receive their surgery sooner.

A more recent study, conducted in 2009, was done to look at costs of TJR surgery by measuring number of hospitalizations and physician visits over three one-year periods (pre-surgery, peri-operative and post-surgery) for those who had TJR surgery and this was compared to controls, matched for age, sex and region of residence and clinical characteristics (comorbidity and type of arthritis) but who were not undergoing TJR. In the year before surgery, cases were found to have costs of $1519 due to physician visits while the cost of that for controls was $1269 and this difference was found to be significant ($p=0.01$). Overall, the health services utilization was greater after surgery than

before; however, costs due to physician visits were lower after the procedure. It was found that although there was no significant change in health services utilization after the joint replacement, when arthritis-attributable costs (which were costs due to arthritis only) were considered, the health services utilization was found to be lower after the procedure, while that for controls was found to increase (Hawker et al., 2009).

One study was found that looked at health service costs (through physician claims) for patients waiting for five different types of elective surgery. Among those waiting for hip and knee surgery, it was found that the length of the wait time was not associated with increased health service costs from physician claims. However, the wait time measured was the time on the wait list only and was limited to 250 days to control for the fact that those waiting longer are more likely to have more physician visits due to the passage of time. Length of stay was also measured in this study and it was noted that those with a shorter length of stay and a longer wait time did not have more physician visits, making it likely that they are less disabled than those with shorter wait times for TJR surgery (Quan et al, 2002). However, because only the time on the wait list was used and limited to 250 days, it is likely that much information is missed. For example, many visits may have occurred before the 250 day limit that may have impacted on the results.

Although a lengthy wait time was not found to be associated with an increase in physician visits or hospitalizations, it cannot be said that those waiting are not negatively impacted. Other data such as pharmacy data and/or HRQoL data could provide a more

detailed picture of the patients while they were waiting. Knee replacement patients were found to be more likely to have a higher number of physician visits and hospital separations during the wait time and they were also found to have longer wait times than hip replacement patients. Therefore, reducing the wait time for this group of patients would help minimize the effect on the health care system.

5.4.3 Comorbidities

No previous studies have compared the number of comorbidities in the time before the wait time start to comorbidities diagnosed during the wait time. Some studies, however, have looked at the number of comorbidities among patients who are waiting for TJR. A large scale population-based study in the United States from 1990-2004 reported an increase in the prevalence of certain comorbidities over time (Memtsoudis et al., 2008). Similar to the present study, it was found that hypertension, diabetes, pulmonary disease (asthma, COPD), were the most common comorbidities, with hypertension affecting more than half of the patients.

Rates of some of the chronic conditions were higher among this sample compared to estimates from the Canadian Community Health Survey (Statistics Canada, 2009). Among residents in the Eastern region of Newfoundland and Labrador, 8.1% reported themselves as having been diagnosed with diabetes, 7.8% with asthma and 18.5% with hypertension. Because the majority of individuals in this study were older, it is evident that rates for chronic conditions would be higher than that among the population.

According to Statistics Canada (2009) rates of hypertension among those in the Eastern region of NL for those aged 65 and older increased to 52.1% which is still lower than the numbers found in this sample of 77.8%.

Previous studies have reported hypertension and diabetes as well as stomach ulcers, asthma and COPD to be common comorbidities among people with arthritis (Marks & Allegrante, 2002; Rosemann et al., 2007a; Tuominen et al., 2007). Among those patients waiting for TJR surgery, HRQoL has been shown to be significantly worse for patients with comorbidities (Tuominen et al., 2007). In addition, one study described a higher prevalence of depression among people with arthritis (Rosemann et al., 2007b) which was found in this study as well. It is unclear though, whether the limitations associated with advanced arthritis lead to an increased risk of developing chronic conditions or whether having chronic conditions make one more susceptible to developing arthritis. However, it is clear that patients with arthritis are likely to have an increased burden of illness.

One study looked at comorbidities and the length of the wait time for TJR surgery and found no difference in wait time when comparing those with higher number of comorbidities (Kelly et al., 2002). Studies that have reported on the number of comorbidities among people waiting for TJR surgery, have described a mean of just over two (Rosemann et al., 2007a; Tuominen et al., 2007). However, the point in time of measuring the comorbidities has not been consistent, with some studies counting the

number at the beginning of the wait others mid-way through the wait and others at the time of the procedure. Therefore, it is difficult to compare with the results of this study. Overall, however, the numbers of comorbidities among patients in this population are at increased risk of having chronic conditions than those in the general population. Whether this is associated with the time spent waiting for surgery is not clear.

It has been shown that there is an increasing need for TJR surgery over the last decade (CIIHI, 2007; Dunbar et al., 2009). In addition, it has been shown that those needing TJR are more likely to have comorbidities. Therefore, there is a high demand on the health care system that is likely to continue. Performing TJR surgery on patients before comorbidities develop could be a way to minimize the impact on both the patients as well as the healthcare system.

5.5 Strengths and Limitations

This is the first known study that has examined wait times for total joint replacement, health service utilization and comorbidities in the Newfoundland and Labrador population. The study covered patients who underwent TJR surgery over a three-year time period, which is not long enough to establish temporal trends; however it did allow for a large sample size. Overall the quality of the data was good with respect to the linkages to other administrative datasets. However, missing steps along the total wait time such as the referral date and the date of placement on the wait list meant that tracking the true total wait time for individuals was not possible. Therefore, the study

measured total wait time using a "proxy" wait time start (referral date) which is likely an underestimation of the actual total wait time. It would be beneficial for a future study to investigate whether a proxy referral date such as this was appropriate. The use of a chart review to compare the proxy date to the actual referral date would be helpful for future studies.

Also, because administrative datasets were used, variables such as body mass index, lifestyle factors (such as smoking), and HRQoL, were unavailable which would have added value to the analysis. These variables would be especially useful with respect to comorbidities and outcomes. However, a strength of the present study was that using the negative binomial regression allowed for analysis of count data over time without limiting the time period as was done in other studies.

A further limitation of the study is that the wait time includes days when the patient was unavailable, therefore it cannot be distinguished whether the total wait time for those in the long and very long wait time groups are due to patient delays or system delays. Some would argue that the time from the first specialist visit until placement on the wait list should not be included as part of the total wait time because of occurrence of patient delays (for example, patients wanting to delay surgery until after they retire) or because of the doctors wanting to wait before doing the surgery. However, this can also be taken as a strength of the study because few studies have looked at this total wait time, and it does take into consideration the whole wait times that patients experience.

The lack of a standard definition for "total wait time" and the use of the proxy referral date meant that direct comparisons could not be made. As standards are being put in place around the reporting of wait times, the goal is that this will be less of an issue in the future. Newfoundland and Labrador has been making progress in meeting the benchmarks for wait times over the last few years. However, more emphasis should be placed on the total wait time as patients are waiting a great deal of time before getting placed on a wait list. In addition, if further work can show that performing surgery earlier can decrease the likelihood of comorbidities, as well as decrease pain and the need for increasing health service utilization while patients are waiting, than this would be beneficial to both the patient and the health care system.

CHAPTER 6

CONCLUSIONS

Wait times for total joint replacement surgery in the Eastern region of Newfoundland and Labrador are lengthy. The wait times normally reported include only the time waited on an official wait list, but patients are waiting extended periods of time before getting placed on this list. Further emphasis should be placed on reducing the total wait time, from referral to surgery, in order to have a greater impact on patients and the health care system. Also, prioritizing patients who are waiting for surgery can enable those with worse conditions to get their surgery sooner. This would be most beneficial if the prioritization occurred at the same time as the referral date as it has been shown that a long wait often occurs before getting placed on the wait list.

Administrative data has been shown to be useful with respect to measuring wait times as well as tracking patients while they are waiting. In the future, because of the upcoming electronic health record in Newfoundland and Labrador and the Pharmacy Network, more information will be available to determine patient outcomes. Even though in this study, the functional ability of patients was unable to be assessed, previous work has shown that the more functionally limited patients are less likely to improve to the same levels after surgery as those who were not as impaired. Therefore further work in this area could include a population-based study of TJR patients in Newfoundland and Labrador that uses these databases as well as possibly including qualitative data and further patient

characteristics (such as BMI) to obtain information such as health related quality of life while patients are waiting for TJR surgery.

As comorbidities increase in the population and the demand for total joint replacement surgery grows, the demand on the health care system will increase greatly. The monitoring of patients waiting for total joint replacement surgery before they even get on the wait list for surgery could be considered. This can allow for patients who are at increased risk of developing comorbidities, which would further delay their surgery, to get fast-tracked and therefore receive the procedure before the comorbidities develop.

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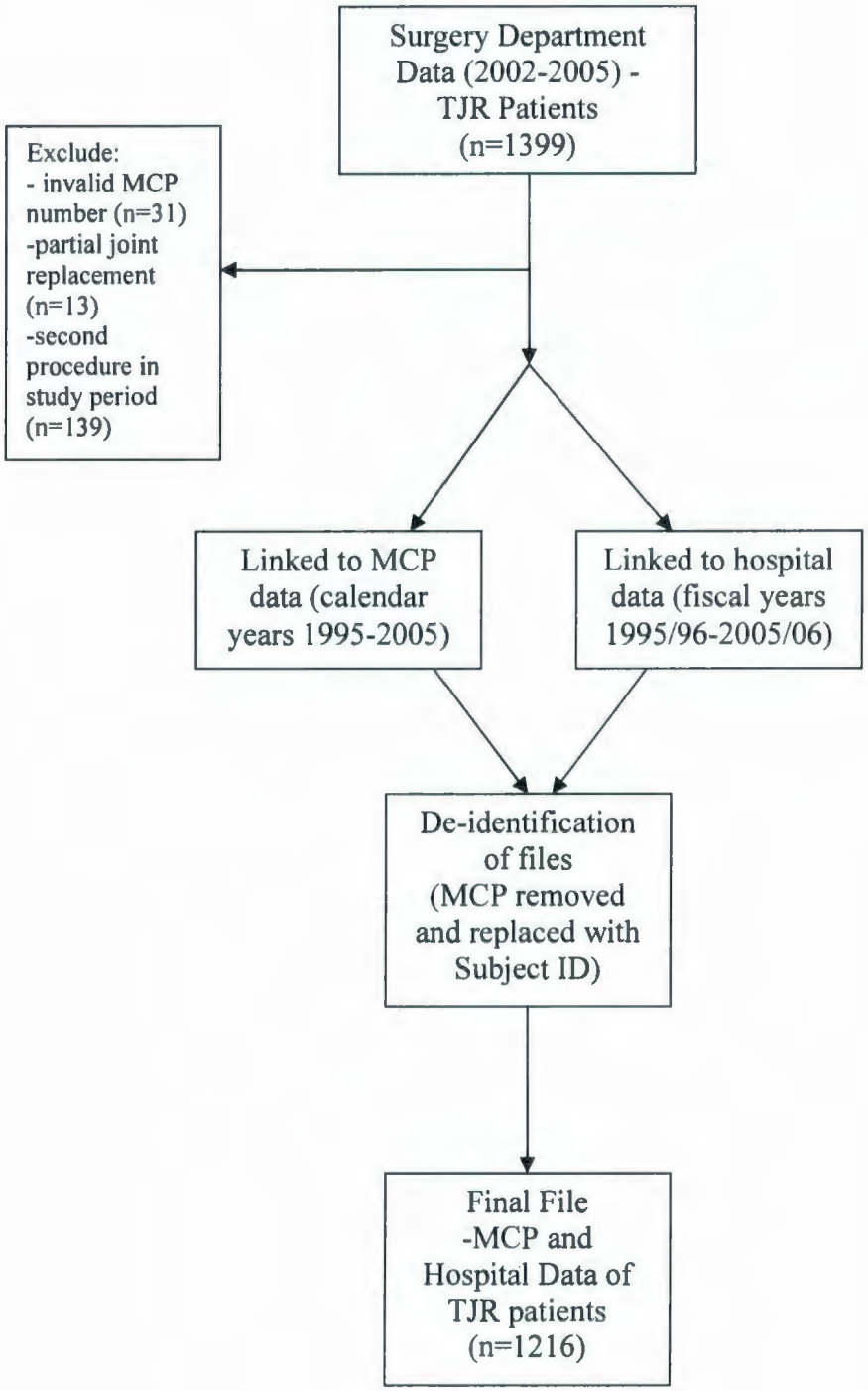
Appendix A: Linkage process



Appendix B: Human Investigation Committee approval letter

Faculty of Medicine

January X, 200[illegible]

Reference #06.28

Ms. T. Chislett
Co Dr. R. Audas
Community Health
2nd Floor Faculty of Medicine

Dear Ms Chislett

This will acknowledge the completed amendment form dated December 18, 200[illegible] wherein you request an amendment to provide Dr. Rick Audas access to data for your research task entitled **"Does longer wait times for total joint replacement contribute to a greater incidence of comorbidities?".**

The Chairs of the Human Investigation Committee reviewed your correspondence and approved the amendment as submitted. This will be reported to the full Human Investigation Committee, for their information at the meeting scheduled for **January 17, 2008.**

This Research Ethics Board (the HIC) has reviewed the amendment for the study which is to be conducted by you as the qualified investigator named above at the specified study site. This approval and the views of this Research Ethics Board have been documented in writing. In addition, please be advised that the Human Investigation Committee currently operates according to the Tri-Council Policy Statement and applicable laws and regulations.

Sincerely,

Richard Neuman, PhD
Co-Chair
Human Investigation Committee

John Harnett, MD, FRCPC
Co-Chair
Human Investigation Committee

RN:JH:jd

C: Dr. C. Loomis, Vice-President (Research), MUN
Mr. W. Miller, Senior Director, Corporate Strategy & Research, Eastern Health